Innovative Vehicle Tweaks Lower Emissions to Meet New Global Regulations

By Maryruth Belsey Priebe

Abstract

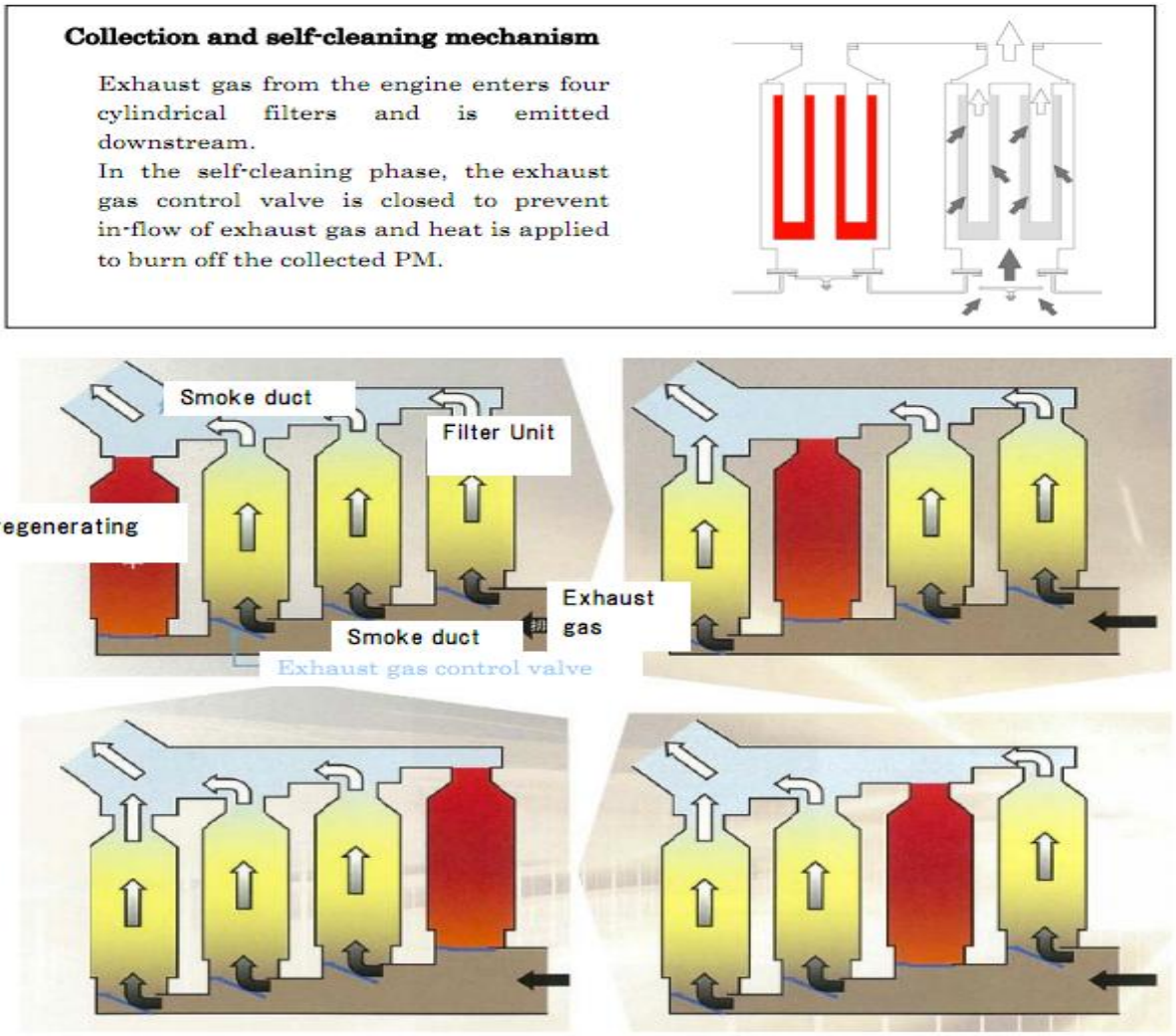
Competition is heating as automakers work toward creating more fuel efficient vehicle ahead of government regulations and consumer demand. Research into many aspects of the conventional combustion engine results in significant performance and emissions control.

Is it possible to create an emissions-free engine? The challenge is a tremendous one, but it's a challenge many automakers, researchers, and engineers are diligently trying to overcome in their quest not only to produce the first zero emissions vehicle, but also out of necessity. With increased energy efficiency standards and government guidelines for environmental compatibility, the drive to innovate to remain compliant with emissions regulations is in high gear.

Yet, given that gasoline will likely be the fuel of choice for vehicles in the near-term future, there is still plenty of motivation to create much greener combustion engines as transition vehicles before the zero carbon economy fully matures. The number and type of vehicle innovations to that end are diverse and interesting.

Particulate Matter and Particular Filter Technologies

Particulate matter (PM_{10}), which refers to tiny bits of dust floating in the air, sized 10 micrometres (10 microns) or less, are produced by many sources not least of which are combustion engines that burn fossil fuels. Given their propensity for becoming embedded in the lungs of humans and other animals, causing numerous health problems, PM_{10} is a major concern for governments and automakers alike.



MOL's Diesel Particulate Filter (DPF)

One of the primary methods of reducing particulate emissions is to install a particulate filtering system. Mitsui, with the help of MOL, Nippon Kaiji Kyokai, and Akasaka Diesels, are currently demonstrating a diesel particulate filter (DPF). This system works by combining a silicon carbide ceramic fibre filter, one that collects particulate matter as exhaust passes through it, with a self-cleaning system that automatically combusts and eliminates particulate matter buildup from within the filter. The system is therefore able to operate continually without filter clogging.

A new challenge for heavy duty vehicles that run on diesel is the high nanoparticle emissions measured when aftertreatment systems are in use. A study by West Virginia University suggests that heavy duty vehicles equipped with urea-based selective catalytic reduction (SCR) systems operating over the critical exhaust temperature in favourable ambient dilution conditions may have higher nanoparticle concentrations orders of magnitude higher than they should be. New technologies will need to be explored to overcome this challenge.

Another option for controlling particulate emissions is to change the type of engine used. For vehicles, particulates are generally formed as a result of an imperfect formation of the mixture in a combustion chamber, giving direct injection engines a significant disadvantage compared to multi-point fuel injection (MPFI) engines. This explains why MPFI engines are currently already under the proposed EURO 6 standards that are set to come into effect September 2014, whereas direct injection engines are not yet compliant. This means direct injection technology will require further innovation in order to meet the new standard.

Several technologies are being explored to reduce the particulate emissions from gasoline direct injection engines. Technologies will be focused a several factors, including the following:

- Acceleration of the warm up phase of an engine and the three-way catalyst system in order to lower vehicle emissions.
- Optimization of the fuel and air paths, and their interaction with one another.
- Precise metering and timing of small fuel masses in the direct injection fuel system to prevent rich regions in the combustion chamber, provide effective atomization with reduced penetration, and avoid spray wall interaction.
- Create faster engine controls and algorithms in order to process the control tasks in a timely fashion.
- Optimization of the hardware and calibration of direct injection gasoline engines.
- Addition of particulate filter systems for cleaning up exhaust gases.

Though MPFI engines are currently further advanced in their particulate matter handling, most studies indicate that both MPFI and direct injection engines can reach the EURO 6 emission standards.[i]

But there are still other strategies for dealing with particulate emissions. Exhaust measurement technology is another solution for limiting the quantity of particulate matter emitted by a vehicle. Mercedes-Benz, for instance, has developed their own energy transparent vehicle development tool that employs an extremely precise metrology system to record 300 energy relevant measurement points.

Given that the system has a sampling rate of up to 1,000 measured values every second, the system can provide 2.4 million measured values every minute, providing extremely accurate and detailed information which can then be used to pinpoint optimization potential. The hope is that this type of technology can be used both at the individual component level as well as at the entire vehicle level.

Automotive Engineering and Construction for Lower Tailpipe Emissions

Many vehicle manufacturers are also in the process of upgrading their powertrain systems to meet the growing demand for more fuel efficient vehicles and in order to remain compliant with government regulations for tailpipe emissions. Many tweaks to existing systems are being made.

Ford, for instance, recently announced that it would be upgrading its entire powertrain portfolio and bringing 20 advanced engines and transmissions to their line of Chinese vehicles. Kumar Galhotra, vice president, Product Development, Ford Asia Pacific and Africa, recently commented, "These technologies represent a core part of our near-term sustainability goals in China. All these new vehicles will launch with the latest Ford-developed powertrains which will improve fuel economy and lower carbon dioxide emissions, offering our customers a more environment-friendly ride without compromising vehicle performance."

Their EcoBoost engine is the cornerstone of this roll-out. This engine, which is made with turbocharging, direct injection, and Ti-VCT technology, is supposed to be 20% more fuel efficient, with 15% fewer carbon dioxide emissions. It's a smaller engine but still has the same power, thanks to their replacement of the old naturally-

aspirated with the new design. This helps to lower overall system cost as well, making it an attractive solution for the company.

Ford's not the only one upgrading its powertrain portfolio. Many other powertrain innovations are being implemented to create more fuel efficient vehicles that emit fewer pollutants and greenhouse gases.

NOx Aftertreatment Technologies

Despite the many advances in engine technologies and electronic control devices for reducing exhaust emissions, NOx and particulate emissions are still above future regulatory standards. Proposed EURO 6 emission standards for the European Union have yet to be finalized, though many details have all but been determined. For instance, it is fairly certain that aftertreatment technologies will require some kind of filtering in the new legislation, and that this may entail some combination of SCR, EGR, and particulate filtering concepts.

One type of technology being used for NOx emissions is aftertreatment. Two concepts are often applied to the problem: selective catalytic reduction (SCR) and NOx absorber catalyst (NAC) technology, which together should be the key to meeting required NOx reduction efficiencies. For instance, NOx absorber catalyst technology may involve strategies such as rich engine calibration, holistic desolation, more sophisticated control strategies, external fuel injectors and reformers, better lean to rich transitions, and so on.

Selective catalytic reduction technology, on the other hand, involves strategies such as close-loop control strategies, more accurate vehicle calibration and SCR calibration, and more sensitive sensors.

Sensata has developed several exhaust gas aftertreatment solutions. Their exhaust gas back-pressure (EBP) sensors, for instance, are used to control back pressure in engines with or without diesel particle filters (DPFs) to protect against engine damage due to overpressure, but also provide sensory data for the diesel particle filter for diagnostic purposes.

Another solution for meeting NOx standards is to employ a lean NOx trap (LNT). These are made using an absorption material such as barium oxide. NOx binds with

this absorption material (referred to as receptor sites) at low exhaust gas temperatures. This system has the advantage of requiring no catalyst consumption, which means very easy maintenance. These systems have not been commonly used until now due to cost and requirements for complexity, as well as the need for low-sulfur fuels. But with better sensor technologies and controls, combined with stricter emissions standards, these are likely to become more common.

It's clear that the collective drive for efficiency on the part of automakers will ultimately lead to better, more efficient, longer lasting vehicles that are sustainable and high performing. Many advances have already been made, but it's clear that there's still a ways to go before the zero emissions mark will be achieved.

Want to know more about advanced vehicle emissions? For more articles, white papers, interviews and much more go to:

http://bit.ly/advanced-emission

Author Bio

A student of all things green, Maryruth has a special interest in cleantech and green buildings. In recent years, Maryruth has worked as the senior editor of The Green Economy magazine, is a regular blogger for several green business ventures, and has contributed to the editorial content of not one, but two eco-living websites: www.ecolife.com and www.GreenYour.com. You can learn more about Maryruth's work by visiting her site, www.jadecreative.com

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Sources:

[1] *Strategies Towards Meeting Future Particulate Matter Emission Requirements in Homogeneous Gasoline Direct Injection Engines*. (2011, April 12). Retrieved February 2012, from SAE International: http://delphi.com/pdf/techpapers/2011-01-1212.pdf