Automakers Race to Lower Emissions Ahead of Coming Standards

By Maryruth Belsey Priebe

Abstract

The standards have been set, and automakers are racing in the direction of lower emissions and greater fuel efficiency. With greater harmonization of codes across the globe, automakers will soon have near-equal standards for which to reach, which is good news for the environment and the average driver.

Governments around the world – most significantly those in Europe, the US, and Japan – are tightening their regulations for vehicle emissions, and that means OEMs and vehicle manufacturers are on the hunt for technologies that will clean-up tailpipe emissions as cost-effectively as possible. Given the complexities of traditional engines, it's no surprise that there are plenty of opportunities for increased efficiency and more methods for lowering criteria pollutants and greenhouse gas emissions like CO2. As researchers explore and test various options, deadlines for cleaner vehicles loom large.

Comparing International Emissions Regulations

Governments worldwide have been targeting vehicle emissions as one of the major sources of both greenhouse gas emissions like CO2, as well as air pollutants such as NOx and particulate matter, both implicit in common smog problems as well as a whole list of human health and environmental problems. To reduce tailpipe emissions, governments been setting increasingly more stringent standards to encourage automakers to boost their vehicles' efficiency and cleanliness. We'll provide a brief overview of these standards for comparison, but it will become fairly obvious that there are more similarities than differences in the standards. This will make it easier for automakers in their quest for achieving goals that will work across a number of different markets.

European Union EURO Exhaust Emissions Standards

The following is a summary of the standards set (and proposed) for the European Union for passenger vehicles and light commercial vehicles ≤1305 kg. EURO 5 standards are currently in force, while the EURO 6 standards are set to come online in September of 2014. It should also be noted that EURO 6 is supposed to require a particulate number (PN) for all spark ignition (SI) vehicles in addition to the emissions standards proposed, though this has yet to be finalized.

EURO 5 diesel vehicle emission standards

- Carbon monoxide (CO): 500 mg/km
- Particulates (PM): 5 mg/km
- Nitrogen oxides (NOx): 180 mg/km
- Combined hydrocarbon and nitrogen oxide emissions: 230 mg/km

EURO 5 gasoline, natural gas, or LPG vehicle emission standards

- Carbon monoxide (CO): 1,000 mg/km
- Non-methane hydrocarbons: 68 mg/km
- Total hydrocarbons: 100 mg/km
- Particulates (PM): 5 mg/km (direct injection gasoline vehicles only)
- Nitrogen oxides (NOx): 60 mg/km

Proposed EURO 6 diesel vehicle emission standards

- Carbon monoxide (CO): 500 mg/km
- Particulates (PM): 5 mg/km
- Nitrogen oxides (NOx): 80 mg/km
- Combined hydrocarbon and nitrogen oxide emissions: 170 mg/km

Proposed EURO 6 gasoline, natural gas, or LPG vehicle emission standards [no change from EURO 5]

- Carbon monoxide (CO): 1,000 mg/km
- Non-methane hydrocarbons: 68 mg/km
- Total hydrocarbons: 100 mg/km
- Particulates (PM): 5 mg/km (direct injection gasoline vehicles only)
- Nitrogen oxides (NOx): 60 mg/km

US Federal Exhaust Emissions Standards

While the American government has chosen to approach their vehicle emission standards a little differently than the EU, they have nonetheless set some relatively stringent targets for the coming years. Several bins have been developed into which

companies can allot various models, with automakers required to reach certain efficiency levels across their entire fleet. US Federal Tier II Standard Bin 5, which is a rough estimation of what fleet averages should be, is what is summarized here, though there are several other bins and tiers within the program. These are the standards that apply to cars and trucks up to 8,500 lbs GVWR for gasoline, diesel, and all other fuels.

- Carbon monoxide (CO): 2,113 mg/km to 2,609 mg/km (3.4 to 4.2 g/mi)
- Non-methane organic gases: 46.6 mg/km to 55.9 mg/km (0.075 to 0.090 g/mi)
- Formaldehyde: 9.3 mg/km to 11.2 mg/km (0.015 to 0.018 g/mi)
- Particulates (PM): 6.2 mg/km (0.01 g/mi)
- Nitrogen oxides (NOx): 31.1 mg/km to 43.5 mg/km (0.05 to 0.07 g/mi)

Japan's Current Vehicle Emissions Standards

Japan is another nation with increasingly more stringent emissions standards for their motorized vehicles. Following are the standards set through the 8th Recommendation from the Central Environmental Counsel for October 2009/September 2010 (passenger gasoline and LPG fueled vehicles).

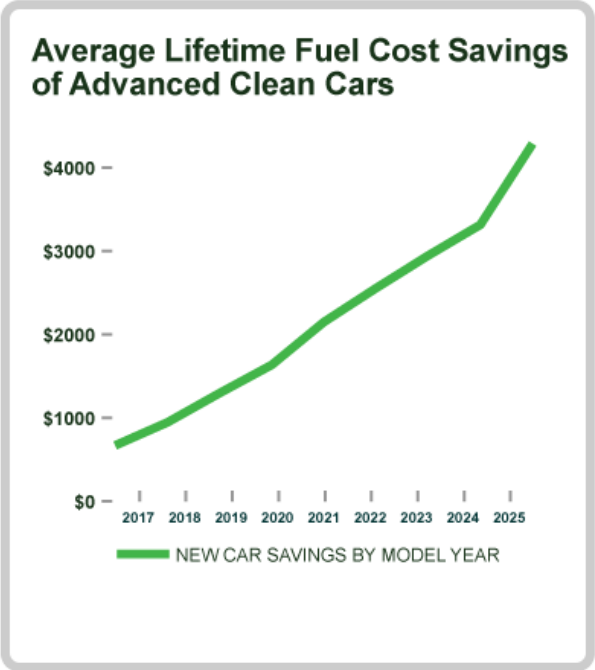
- Carbon monoxide (CO): 1,150 to 1,920 mg/km
- Particulates (PM): 5 mg/km to 7 mg/km
- Nitrogen oxides (NOx): 50 mg/km to 80 mg/km
- Hydrocarbon emissions: 50 mg/km to 80 mg/km

Japan 8th Recommendation from the Central Environmental Counsel for October 2009/September 2010 (passenger diesel vehicles)

- Carbon monoxide (CO): 630 mg/km to 840 mg/km
- Non-methane hydrocarbons: 24 mg/km to 32 mg/km
- Particulates (PM): 5 mg/km to 7 mg/km
- Nitrogen oxides (NOx): 80 mg/km to 110 mg/km

California Air Resources Board Low Emission Vehicle Program

The California Air Resources Board (CARB) has also passed their own Advanced Clean Cars (ACC) program that will set more stringent standards for emissions from light-duty (LD) and heavy-duty (HD) vehicles. The ACC program is meant to help the state meet its 2050 greenhouse gas reduction goal of 80% below 1990 levels, and will require that most vehicles be composed of advanced technology vehicles, including fuel cells, battery electrics, and the like.



California's Advanced Clean Car Program

Their Low Emission Vehicle (LEV) Program has two main components: more stringent regulations for criteria pollutants (LEV III) as well as regulations for greenhouse gas emissions. LEV III replaces separate non-methane organic gases (NMOG) and NOx standards with a combined standard for both, creates even more stringent standards for particulate matter emissions for light duty and medium duty vehicles, and sets the fleet average emissions for new passenger cars, light duty trucks, and medium duty passenger vehicles to US federal Tier 2 Bin 2 levels by 2025.

Additionally, the LEV III requirements set the life durability bar to 150,000 miles instead of the 120,000 so that the ultra-low emission vehicles work efficiently for longer.[i] Heavy duty vehicles will also be required to control emissions, like with additional control equipment like hydrocarbon and secondary air absorbers, though these regulations have yet to be finalized.

Technological Advances to Meet Current and Future Regulations

Automakers are working with a variety of solutions to meet the above regulatory requirements, tackling the problem from every angle possible. Following is a brief sampling of some of the technologies being used to achieve greater vehicle performance and better environmental compliance.

Solving Engine Knock with Innovation Solutions for Greater Efficiency

Knocking behaviour is perhaps the biggest source of inefficiency in a SI engine, and can lead to a variety of adverse effects for efficiency. Knocking can reduce CR, which in turn can lead to fundamental restrictions on efficiency. Knocking can also retard combustion phasing, which results in high exhaust temperatures (and ultimately enrichment) or poor cycle efficiency at high loads. Knocking can also reduce specific power which reduces downsizing benefits and thereby contribute more friction.

Many strategies have been used to address engine knock. The US Department of Energy recently awarded funds to various projects to work on advanced vehicle technologies. One of those technologies is the MIT advanced fuels which enables diesel-like efficiency and maximum power output while suppressing engine knock under high loads.

Another approach is more technological. Freescale has recently introduced a powerful microcontroller for powertrain systems that has benefits for engine knock. Traditionally, knock detection is provided by external ICs. But with Freescale's new on-board chip, knock windows (1/1000 of a second time window) can be predicted within the engine noise, and compensated for to improve system performance. Freescale maintains that with their system, other components, such as discrete knock ASICs, external ADC, filters, and multiplexers can all be eliminated.

Advanced Technologies for NOx Filtration

An alternative technology being employed by OEMs to offer cleaner emissions is substrate technology for NOx emission control. Active catalysts are supported on substrates of ceramic or metal within the exhaust system. Today's substrates are significantly more advanced than they once were, with cells per square inch (cpsi) reaching up to 1,200 at a wall thickness of as little as 0.025 mm. By reducing the wall thickness, the thermal capacity is also reduced while limiting pressure losses.

Together, these features make it possible for autocatalysts to reach ever higher efficiencies. By combining improved substrate technology with thermally stable catalysts and oxygen storage components, close-coupled catalyst systems can easily meet EURO 6 standards and California Super Ultra Low Emission Vehicle (SULEV) regulations.

Emission control systems in HEVs

Hybrid electric vehicles (HEVs) pose new challenges to engineers and product developers when looking to meet more stringent emission standards. In particular, hybrids limit combustion engine operation, making technical solutions and technologies for the adaptation of evaporative emissions control systems somewhat more difficult.

Several OEMs are working on emission control systems in HEVs to meet upcoming emission standards. Delphi, for instance, has been testing an integrated emission control product applicable to hybrids with open and sealed fuel systems that combines carbon canisters, canister modules, and electrically heated hydrocarbon scrubbers for both integrated and non-integrated fuel systems.

The Delphi hybrid evaporative emissions system is supposed to provide increased canister regeneration efficiency to enable the best evaporative emissions control in low purge engine operation. Not only is this plug and play module easy to install in existing systems, it is purported to be able to eliminate the need for pressurized steel systems in partial zero-emissions vehicles (PZEV), which has the follow-on benefit of being able to lower production costs with a plastic fuel tank.

With a regulatory fire lighting the current strides to sustainability, automakers no doubt will continue to make great innovations reality in the function and construction of their vehicles.

Want to know more about advanced vehicle emissions? For more interesting 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

Image Credits

California's Advanced Clean Cars Program via CARB
City smog via Flickr: Yuri Virovets

Sources:

[1] *California's Advanced Clean Cars program: transforming the light-duty fleet to zero-emission hydrogen fuel cell and electric vehicles with an eye on 2050*. (2011, November 18). Retrieved 21 2012, February, from Green Car Congress: http://www.greencarcongress.com/2011/11/acc-20111118.html