Euro 7: An opportunity to significantly reduce evaporative emissions from internal combustion engine vehicles

In line with the current European efforts to improve air quality, all vehicles should be contributing to emission reductions. Considering that internal combustion engine (ICE) vehicles will continue being operated in the vehicle fleet for at least the next 20 years, emissions must be minimized, and the fuel must be used as efficiently as possible.

Key Euro 7 proposals being considered to achieve these goals for evaporative and refueling emissions are:

- Introducing an **on-board refueling vapor recovery (ORVR)** system to increase refueling efficiency to 98%[1] versus to 55-85%[2,3] with current Stage II technology, in real world operation.

- Regulating **on-board diagnostics (OBD)** for evaporative leak detection with existing proven technology to improve control system integrity for the full life of the vehicle and avoid uncontrolled emission

- Establishing **more stringent evaporative emission limits of 0.30 g/day** to encourage the use of available near-zero evaporative control technologies, including fuel vapor permeation controls.

These commercially available technologies (ORVR, OBD, and permeation control) are already deployed in other regions such as U.S., China, Brazil and Canada and should be required for all ICE-containing, petrol-fueled vehicles to reduce non-tailpipe, evaporative emissions of non-methane volatile organic compounds (NMVOC).

Key benefits of applying these technologies to European vehicles include:

- Aligning with the zero-pollution ambition set forth in the European Green Deal[4,5] to deliver better air quality for EU citizens

- Enabling significant reductions in NMVOC to reduce ozone and PM2.5 air quality exceedances and contribute to Member States' NMVOC National Emission Reduction Commitments

- Allowing the European Union to set harmonized global standards for near-zero evaporative controls, leading to cost savings through economies of scale and streamlining of certification for the industry

[1] SAE Technical Paper 2017-01-5008, "Summary and Analysis of 2000-2015 Model Year IUVP Evaporative and Refueling Emission Data"

[2] Directive 2009/126/EC on Stage II petrol vapor recovery during refueling of motor vehicles at service stations

[3] Slide 62 of CLOVE presentation to AGVES on 27 October 2020 notes 55-85% efficiency for Stage II control (here)

[4] COM 2019/640 Communication and roadmap on the European Green Deal, 11 December 2019

[5] COM 2021/400 Communication on EU Action Plan: "Towards Zero Pollution for Air, Water and Soil" and annexes, 12 May 2021

Introduction

The European Green Deal promises consistent targets for the reduction of polluting emissions. As a key deliverable, the Zero Pollution Action Plan sets the vision to improve air quality and reduce premature deaths caused by multi-sector air pollution by at least 55% by 2030. To achieve these goals in the transport sector, the Sustainable and Smart Mobility Strategy outlays a plan for the development of renewable low-carbon fuels and low-emission vehicles with a focus on climate neutrality, energy efficiency and circular economy.

Although the production and integration of battery electric vehicles (BEV) and fuel cell electric vehicles (FCEV) is now a priority, any new ICE-containing vehicles sold in the transition (including PHEVs) will remain on the road for 10-20 years. Thus, all ICE-containing vehicles can and should be brought closer to zero emissions in a cost-effective manner to contribute to the emission reductions needed for air quality improvements. A key proposal to achieve these goals is the revision of the Euro7 regulation to introduce more stringent emission standards.

The introduction of proven and cost-effective control technology to reduce evaporative emissions, including on-board refueling vapor recovery (ORVR), on-board diagnostics (OBD) for leak detection, and increased stringency of the limits are all essential components of the Euro 7 regulation.

Enhancing the control of evaporative emissions for a better air quality for EU citizens

Pollutants emitted by ICE vehicles from the exhaust system, evaporative system and during refueling, such as NO_x, PM and NMVOCs, significantly contribute to poorer air quality in Europe. Specifically, current scientific data suggests that over 60% of vehicle NMVOC emissions from petrol-fueled ICE are evaporative emissions emitted from the fuel system prior to combustion[6]. Emissions of NMVOCs are particularly important as they contain toxic components and also contribute, along with NO_x, to the formation of ozone and react with other volatile species to form secondary particulate matter ($PM_{2.5}$) and haze.

This is especially the case in European urban areas which face severe health and air quality impacts during summer, especially during heatwaves[7]. Because both NMVOC and NO_x are precursors contributing to the ozone and secondary $PM_{2.5}$, reducing NO_x without reducing NMVOC can lead to increases in ozone and $PM_{2.5}$[8]. Successful efforts by regulators and automakers have been made over past decades to significantly reduce NO_x with strict emission limits, bans and fines to ensure the health and safety of citizens and the environment. However, Member States still struggle with reducing their real-world ozone and secondary $PM_{2.5}$ emissions, because the Ambient Air Quality Directive contains no enforceable limit values for these pollutants, and there has not been a coordinated focus on reducing NMVOC in addition to NO_x. It is also worth recalling that NMVOC reductions will support the National Emission Reduction Commitments (NEC) Directive by delivering NMVOC reductions in both the real-world and inventories.

Further control of evaporative emissions is a significant opportunity in Euro 7 to reduce NMVOC emissions for better air quality for EU citizens.

---

[6] EMISIA EU-27 COPERT emission inventory data for 2018 for all European petrol-fueled passenger cars and vans. (here)

[7] European Climate Adaptation Platform Climate-ADAPT, "Heat waves" (here)

[8] Sicard et al., "Amplified ozone pollution in cities during the COVID-19 lockdown" Science of the Total Environment, 2020.

ORVR is a well-proven, globally accepted, low-cost control technology solution for achieving near-zero evaporative refueling emissions

ORVR technology is commercially available and fully developed. Although Europe currently regulates refueling emissions with the Stage II Directive, the maximum efficiency required of Stage II technology at certification is only 85%[2] and in-use efficiency can be significantly reduced to 55% without proper inspection and maintenance[3]. EPA has deployed regular inspection and maintenance and still only achieves 71% efficiency of their Stage II systems[9]. This low efficiency of Stage II is inconsistent with the zero pollution ambition set forth in the European Green Deal. In light of this, ORVR offers a cost-effective system by reducing refueling evaporative emissions by 98% and maintaining this control efficiency over the lifetime of the vehicle without need for maintenance. Furthermore, ORVR is compatible and can even be a complement to the current Stage II vapor control technologies[9].

In addition to being cost-effective for manufacturers, ORVR also offers benefits to the vehicle owner. Indeed, ORVR stores petrol vapors in the canister until the vehicle operates, when the fuel vapors are returned to the engine for combustion, thereby reducing drivers' expenses for fuel. NMVOCs captured on the vehicle are consumed by the engine rather than emitted into the atmosphere. This efficient recovery and utilization of fuel vapor over the lifetime of the vehicle more than offsets the initial control cost for the ORVR system, which averages only €10-20 per vehicle[10].

An ORVR standard in Euro 7 represents an important opportunity to control vehicle emissions of NMVOC in addition to NO_x, at a minimal cost of €10-20 per vehicle. The cost of the ORVR system is fully recovered by the vehicle owner through fuel savings.

The EU has an opportunity to lead the trend on control of vehicle emission standards globally

Finally, European regulations are adopted by other nations through United Nations Economic Commission for Europe (UNECE) agreements and automakers sell vehicles into global markets that currently have no regulations for refueling control. As a result, many countries follow the vehicle emissions standards established by the European Commission. Most of these countries face significant air quality challenges and do not have Stage II as a minimum level of control for refueling vapors. Given that the U.S, China, Canada and Brazil have already adopted ORVR, harmonization of evaporative standards to the greatest extent possible would lead to cost savings through economies of scale and streamlining of certification for the industry.

There will be many changes in the transport industry over the next decades. Electric and hybrid electric vehicles, operating on low and zero carbon fuels, and even advanced ICE vehicles will all play a crucial role in helping to achieve 2050 emission goals. No technology is without its impact on the environment, but all vehicles should be contributing to the emission reductions needed for air quality improvements and effectively participating in the achievement of climate targets.

ORVR, OBD for leak detection, and more stringent limits are key proposals in Euro 7 to ensure all ICE-containing vehicles coming onto the roads are at near-zero evaporative NMVOC emissions, thereby improving air quality for EU citizens.

[9] MECA Refueling Vapor Recovery Whitepaper, February 2020 (here)
[10] MECA estimate based on incremental components costs relative to Euro6d canister system.