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Editorial

Special Issue on Emission Control and Characterization in Hybrid Vehicles

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Electrified powertrains have appeared in recent years as part of the solution to achieve the aggressive targets established for a reduction in greenhouse gas emissions, particularly CO_2. However, the compliance of such proposals with regulations on pollutant emissions has become particularly challenging. First, new certification methodologies are extending both the range of working conditions and the chemical species included in the homologation. Additionally, the deactivation of the thermal engine during the electric driving mode tends to reduce the working temperature of the exhaust gas aftertreatment system, impairing its efficiency during larger portions of its operation. For this reason, new technologies for next-generation hybrid engines are required to reduce the emissions at the engine-out level and improve the performance of the aftertreatment system. This Special Issue collects several breakthrough investigations from different approaches to the current propulsion challenges; these contribute to providing new methodologies and guidelines for engine research and development in the community.

A total of six papers are presented in this Special Issue. Serrano et al. [1] investigated the usage of a bubble reactor to control the humidity of the air stream in altitude simulators for multi-cylinder engine testing. Altitude simulation has become a critical aspect in recent years due to the extension of both temperature (up to -7 °C) and altitude (up to 1300 m) included in Euro 6d testing conditions, further extended in the Euro 7 proposal. Using computational fluid dynamics (CFD) tools, guidelines for the design of such a humidification system as a function of air velocity are provided. Piqueras et al. [2] studied the impact of exhaust gas recirculation (EGR) usage in spark ignition engines from an emissions perspective. While EGR is being widely used for improving the efficiency of new-generation spark ignition engines for hybrid applications, it has a negative impact on combustion performance and, particularly, on unburned hydrocarbon emissions. This change in emission pattern needs to be considered for the definition of the exhaust gas aftertreatment system. It can be particularly critical due to the parallel reduction in nitrogen oxide emissions, inducing chemical competition for the available oxygen between carbon monoxide and unburned hydrocarbons. Therefore, new aftertreatment monoliths with higher oxygen storage capacity and/or new fuel control strategies with longer durations of the lean operation may be needed. Torres et al. [3] investigated the potential of next-generation fuels for compression ignition engines based on synthetic fuels (Fischer–Tropsch derived) and biofuels. From an efficiency point of view, these fuels proved to be comparable to the standard diesel fuel currently used. However, a proper blend of these components has the potential of reducing the total unburned hydrocarbons, nitrogen oxides and ammonia emissions at the tailpipe level, with the only penalty being a slight increase in carbon monoxide. Hydrocarbon speciation showed an increase in the lighter, more volatile components, although the strong reduction in the heavier species drove the overall reduction in the total amount. Martínez-Munuera et al. [4] evaluated ceria-based catalysts without platinum group metal (PGM) content for a low-temperature lean-NO_x trap (LNT) function. Several formulations containing barium and copper were tested at two different working temperatures. The results helped to identify different paths for

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NO_x reduction depending on the catalyst formulation, identifying the importance of the copper content. The results showed that such catalysts can be seen as a path to maintaining the current LNT capability along with a great reduction in PGM content, significantly reducing the overall cost of the system. Capata and Sciubba [5] investigated the design of an innovative turbocharger technology for mild hybrid engine applications. The new concept is based on the decoupling of compressor and turbine components, so that the compressor is driven by a dedicated electric motor, while the energy recuperation in the turbine is used to drive an electric generator. In this way, both turbomachines are designed so that they can operate close to their maximum efficiency, without the restriction of having a common rotational speed and power balance. Particularly, the turbine can be designed with a slightly larger size, with the benefit of backpressure. The results show a potential gain of 5.6% in efficiency due to the implementation of this concept. Finally, Tormos et al. [6] evaluated a new optimization methodology for the energy management strategy (EMS) based on information from the driving conditions for a hybrid electric urban bus. The results show that the algorithm proposed is capable of maintaining the state of charge of the battery system with almost a 10% improvement in fuel consumption compared to the equivalent consumption minimization strategy (ECMS), which is currently standard for hybrid electric vehicle management.

The diversity of the contents found in this Special Issue exemplifies not only the new challenges faced by the powertrain research community but the room for efficient solutions coming from an optimized integration of thermal engines and electrified concepts. This continues to be addressed by looking for cost-effective sustainable and environmentally friendly propulsion solutions.

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