

Editorial

Closing Editorial for the Special Issue “Advances in Green Propulsion Engine and Environmental Pollution Control”

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Developing green propulsion engines and effective environmental pollution control technologies has become an important pathway toward sustainable transportation, low-carbon aviation, and cleaner energy conversion. Aviation's climate impact is associated not only with CO₂ emissions but also with non-CO₂-related effects such as NO_x, water vapor, aerosols, and contrail-related cloudiness [1]. In this context, liquid hydrogen, hydrogen-fueled aero-engines, advanced thermal management, sustainable fuels, and pollutant control technologies are attracting increasing attention as potential routes toward cleaner propulsion systems [2,3]. The Special Issue “Advances in Green Propulsion Engine and Environmental Pollution Control” was organized to provide a forum for discussing recent advances in high-efficiency propulsion systems, aero-engine technologies, alternative fuels, combustion and emission control, thermal management, and related process optimization.

This Special Issue has collected ten papers that address different but closely related aspects of green propulsion and pollution control. Together, these contributions cover variable-geometry turbine leakage reduction, hydrogen-fueled aero-engine modeling, the mechanical reliability of geared turbofan components, combustor liner cooling, centrifugal compressor stability enhancement, diesel spray atomization, plasma-based particulate removal, combustion and emission optimization in opposed rotary piston engines, diesel-biodiesel engine performance, and gas-injection processes in liquid rocket engines. These studies demonstrate the multidisciplinary nature of green propulsion, where progress depends not only on cleaner fuels but also on improved component design, advanced materials, thermal protection, combustion optimization, system-level integration, and exhaust-treatment technologies.

Zhou and Zheng [4] proposed a novel way of reducing leakage loss in variable-geometry turbines. By introducing a spherical convex plate with a pivot shaft, their work provides a practical approach to mitigating leakage driven by pressure gradients, thereby improving the aerodynamic efficiency of variable-geometry turbine systems.

Wang et al. [5] developed transient models for hydrogen-fueled aero-engines and analyzed their performance. Their study integrated hydrogen combustion, heat exchangers, water or steam injection, and rapid NO_x assessment, highlighting the potential of hydrogen-fueled aero-engines to reduce fuel consumption, turbine-entry temperature, and pollutant emissions. This contribution is closely connected to broader research on liquid hydrogen aircraft and hydrogen propulsion technologies [2,3].

Cao and Yang [6] investigated the mechanical behavior and low-cycle-fatigue performance of carburized steel used in geared turbofan engines. Their findings showed that carburized layers and compressive residual stress can significantly improve fatigue life, providing useful guidance for the design and durability assessment of reduction gear systems in advanced aero-engines.



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Li et al. [7] studied tangential effusion cooling for combustor liners through numerical simulation. Their results show that tangential jets can improve cooling-film coverage and reduce wall temperature, helping to provide more reliable thermal protection for high-temperature combustors. This work is also relevant to the broader challenge of thermal management in hydrogen and advanced propulsion systems, where compact heat exchangers and high-performance cooling channels are key enabling technologies [8–11].

Fan et al. [12] examined the influence of self-recirculating casing treatment on ultra-high-pressure-ratio centrifugal compressors. Their numerical study clarifies how casing-treatment geometry affects compressor performance and stability, supporting the design of compact, high-pressure-ratio compression systems for future propulsion applications.

El Marnissi and Hwang [13] used microscopic imaging and extinction measurements to investigate diesel spray and atomization processes. Their work shows that higher injection pressure can reduce droplet size and improve air–fuel mixing, which are important for enhancing combustion efficiency and reducing emissions.

Dorosz et al. [14] explored the use of a cold-plasma gliding arc reactor to remove nanoparticles from diesel exhaust gases, demonstrating non-thermal plasma technology's potential to reduce particulate emissions, especially when residence time and flow conditions are properly controlled.

Song et al. [15] investigated the effects of spark plug position and ignition timing on the combustion and emission characteristics of opposed rotary piston engines, providing optimization guidance for improving power output, fuel consumption, knock resistance, and emission performance in compact engine systems.

Milojević et al. [16] analyzed thermal efficiency and emissions from a diesel engine operated using diesel and biodiesel. Their study emphasizes the practical potential of biodiesel as an alternative fuel while also indicating the importance of suitable engine control strategies for achieving better performance and emission outcomes.

Ma et al. [17] experimentally investigated pressure-drop characteristics during the gas-injection process in a liquid-propellant rocket engine gas generator, providing useful data for understanding gas-injection behavior and improving operations under throttling conditions, findings relevant to propulsion systems' stability and controllability.

Overall, the papers published in this Special Issue reflect several important directions in green propulsion and environmental pollution control. First, component-level efficiency improvement remains essential, as demonstrated by the studies on turbines, compressors, combustor liners, and geared turbofan materials. Second, alternative fuels, especially hydrogen and biodiesel, are becoming increasingly important for reducing carbon emissions and diversifying propulsion energy pathways. Third, combustion optimization and spray characterization continue to be fundamental for improving energy conversion and lowering pollutant formation. Fourth, aftertreatment and pollutant-removal technologies, such as plasma-based nanoparticle control, are necessary complements to cleaner combustion strategies. Finally, advanced modeling, simulation, and experimental diagnostics are indispensable tools for understanding complex propulsion processes and guiding engineering design.

Future research in this field should further strengthen the integration of fuel innovation, component optimization, emissions control, and system-level design. For hydrogen-fueled aero-engines, more studies are needed on transient operation, safety, thermal management, NO_x control, and full-system integration. Supercritical hydrogen heat transfer remains a particularly important topic because strong variations in thermophysical properties, buoyancy effects, thermal acceleration, pseudo-boiling-like behavior, and channel geometry may jointly influence heat-transfer deterioration and flow stability [9–11,18,19]. At the same time, advanced heat exchanger design, including compact heat exchangers,

printed circuit heat exchangers, topology optimization, and additive manufacturing, is expected to play an increasingly important role in future hydrogen propulsion and thermal-management systems [8,9,20].

For conventional and alternative-fuel engines, improvements in injection, combustion, cooling, and exhaust treatment remain key to achieving higher efficiency and lower emissions. In addition, high-fidelity numerical methods, experimental validation, and data-driven optimization are expected to support the design of next-generation green propulsion systems. A more comprehensive assessment of propulsion technologies should also consider both direct emissions and broader climate effects, especially for aviation applications involving hydrogen, sustainable fuels, and high-altitude operation [1–3].

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Conflicts of Interest: The author declares no conflicts of interest.

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