STSXX-Y

Reduced order computational methods for the development of the propulsive technologies for supersonic aviation to achieve climate neutrality

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Key Words: Reduced order models, thermodynamic cycle analysis, jet engines, ramjet, propulsion systems

Modern civil aviation industry is at the verge of entering a new era of radical changes. Predicted demand increase on the air traffic requires exploitation of new flight routes through the novel aircraft design which can fly faster and higher. On the other hand, an unprecedently strong emission reduction requirements from the legislators to reduce the carbon footprint of the civil aviation pushes the industry to exploit cutting edge propulsion technologies enabling the use of carbon neutral and eventually carbon zero fuels. The latter can be addressed by using sustainable aviation fuels (SAF) for long- and mid-haul flights and hydrogen for short-haul routes. In parallel, development of new generation of aircrafts which can fly supersonic speeds at much higher altitudes than the state-of-the-art passenger planes can facilitate exploration of new routes that can release the pressure on the existing flight altitudes. The EU H2020 funded MORE&LESS project [1] aims at addressing the aforementioned research problems by investigation various aircraft concepts and their propulsion systems using different environmentally friendly fuels. A series of theoretical, numerical and experimental studies will be conducted by a consortium of fifteen research institutes and universities to develop critical technologies required to achieve novel aircraft and engine platforms enabling climate neutrality.

The current study presented computational tools aiming at development of propulsion system concepts enabling supersonic flights through simple and combined cycle operation. In this framework, two cruise speeds have been investigated. At Mach 2, the turbine based advanced engine architectures are exploited with and without afterburner. While, at Mach 5, combined cycle propulsion systems are required to achieve airbreathing operation throughout the flight trajectory. The take-off and ascend phases are powered by turbomachinery based cycles while the high supersonic acceleration and cruise are propelled by a ramjet engine. The conceptual design of these propulsion systems is accomplished through unsteady thermodynamic cycle simulations at system level [2]. Detailed design and analysis of the critical components are performed by reduced order models as well as high-fidelity numerical simulations when necessary. Both engine concepts have been simulated for certain flight trajectories and results are discussed to attain the best operational parameters reducing the emissions

REFERENCES

[1] https://cordis.europa.eu/project/id/101006856

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