6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

Drop-in assessment of alternative aviation fuel on engine

Shuiting Ding*, Xiaoyi Yang, Tian Qiu, Chongwen Zhou, Ting Li

School of Energy and Power Engineering, Beihang University, 37 Xueyuan Road, Haidian District, Beijing, China, 100191, dst@buaa.edu.cn

Key Words: *safety criteria in engine, alternative jet fuel, integrated engine model, combustion diagnostic and simulation.*

One of the most challenges in alternative aviation fuel is the lack of clear definition of drop-in fuel, which results in the key question - what kind of difference in fuel and combustion are acceptable in engine. Jet fuel should achieve to provide available thrusts by engines under both of unsteady and steady states in the whole flight envelope. Accordingly, as a result, engine in alternative fuel should conduct the duties at the conditions of flight envelop as petroleum-derived jet fuel including taking-off, climbing, cruising, landing. Performance critical parameters (PCPs) related with engine performance contain thrust, thrust response, specific fuel consumption, exhaust gas temperature, rotors axial force. The deviation of engine performance related with alternative jet fuel effects may lead to the changes of duration and reliability on combustor, hot section, fuel system, which can be integrated as safety critical parameters (SCPs). The critical key parameters of were extracted by fundamental process related with safety and performance on achieving the duty of engine in the whole flight envelop. For achieving the compliance verification of drop-in fuel, parameterization have been carried out for similar analogy. Based on the data of petroleum jet fuel, the integration of SCPs space formed the safety margin of engine as safety criterion while the integration of PCPs formed the work margin of engine as performance criterion which can be used as acceptable criteria to identify drop-in jet fuel [1].

Integrated engine models [2] coupled with three-dimensional transient combustor models were designed with the ability to simulate the engine performance and components interactions. The models can simulate the design performance and off-design performances with an example of the integrated engine model for a typical turbofan engine. Engine components include a fan, compressor, combustor, turbine, and nozzle. The models consist of a plurality of three-dimensional transient combustor sub-models and zero-dimensional transient component sub-models. The engine parameters of specific fuel consumption, thrust, and thrust response can be obtained from the simulation. Besides these engine parameters, individual component performance characteristics, and the working-fluid properties under different operating conditions in the engine, can also be outputted including the compressor exit pressure, turbine inlet temperature, turbine outlet temperature, mass flows and rotor speed under different operating conditions. This paper discussed a methodology to certify drop-in fuel by similar analogy.

REFERENCES

[1] Z. Liu, X. Yang, S. Ding, Assessment the safety of alternative aviation fuels in aero-engine, Proceedings of the ASME 2016 Power and Energy Conference, 2016.

[2] S Ding，T Qiu，X Liu，S Zhang, Dynamic coupled systems FHA: a simulation-aided approach, Procedia Engineering, 2014.