ENABLEH2 Session EASN

Presentation 2:
Hydrogen – A Clean Fuel: "Ultra-low NO_x Hydrogen Micromix Combustion Systems for LH_2-fuelled aircraft"

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Kerosene has relatively narrow combustion stability limits. This leads to problems with lean blow out and combustion instabilities when reducing flame temperatures to implement low NO_x emission combustion technologies. Hydrogen is a promising candidate fuel in this context as it has much larger stability limits and therefore lean combustion is possible without approaching lean blow out limits. Micromix (diffusion) combustion enables superior fuel and air mixing without the risks associated with premixing thereby reducing maximum local flame temperatures leading to ultra-low NO_x emissions.

Within the ENABLEH2 project there is a dedicated work package which comprises complementary experimental and numerical research to mature hydrogen micromix combustion technology.

The work is split into the following three phases:
Phase 1 - Injector array studies to:
1. Assess the predictive capabilities and evaluate validate hydrogen combustion models in state-of-the-art CFD tools namely ANSYS, STAR-CCM+ and AVBP
2. Perform a design space exploration study to identify preferred injector designs and spacing that have the potential to deliver the lowest NOx emissions without compromising other combustor performance and operability criteria.

Phase 2 - Multi-Injector Full Annular Combustor Segment Studies at more representative combustor inlet conditions
Phase 3 - Sub-Atmospheric Altitude relight studies

The overall objectives are:
1. To deliver an optimized hydrogen annular type micromix combustor design that provides ~90% reductions in landing and take-off cycle and mission NO_x relative to Y2000 technologies.
2. To demonstrate that the hydrogen micromix combustor design satisfies design and operational requirements including; satisfactory stability (over a wide range of fuel to air ratios), combustion efficiency (≥99.5%), optimum pressure loss, satisfactory thermoacoustic behaviour, acceptable durability, acceptable outlet radial and circumferential temperature distributions, altitude relight capability, size and weight constraints.
3. To quantify the extent to which NO_x emissions and thermoacoustic instabilities can be further reduced, combustor outlet temperature distribution further customised and liner durability improved by customising the fuel flow for each injector in the micromix injector-array.
4. To perform a thermoacoustic risk assessment of a representative combustor under real engine conditions.
5. To deliver validated analytical combustor design and reduced order NO_x emissions emissions prediction models for the technology evaluation studies

This presentation will provide an overview of the case for hydrogen micromix combustion, details of the planned work in ENABLEH2 and a summary of the achievements and main results to date.