Performance Characteristic of a Multi-fuel Hybrid Engine for Future Aircraft

Introduction

The Advisory Council for Aeronautics Research in Europe (ACARE) has set ambitious objectives for civil aviation for 2050, as shown in Fig. 1. To meet these stringent demands, a novel aircraft and engine configuration are required.

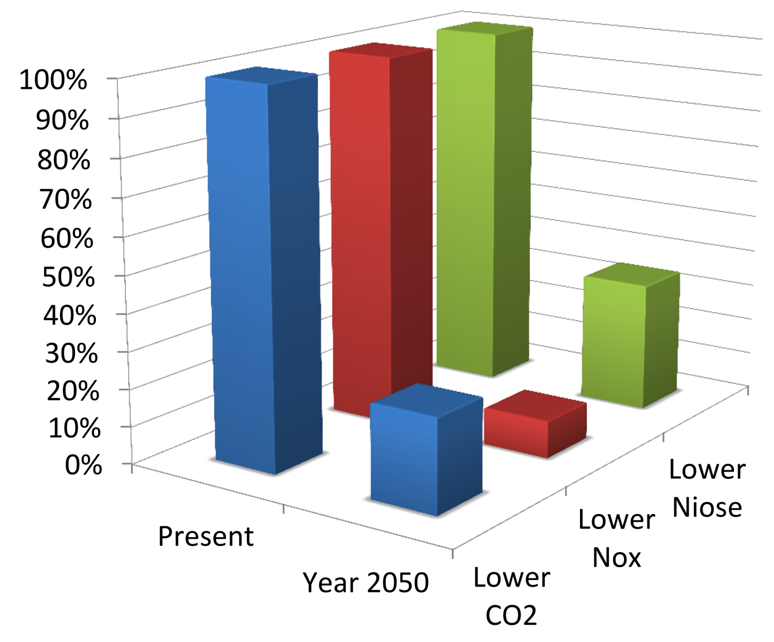

Fig.1: ACARE 2050 Goal

The Novel Aircraft & Engine Concept

To meet the challenges, a multi fuel BWB concept has been conceived (Fig.2). The novel aircraft is designed to carry multi-fuel such as LNG/LH2 and kerosene/biofuel. A new multi-fuel hybrid engine suitable for the multifuel BWB concept is being investigated. The schematic of hybrid engine layout can be seen in Fig. 3.

Fig. 2: The TUDelft BWB aircraft concept

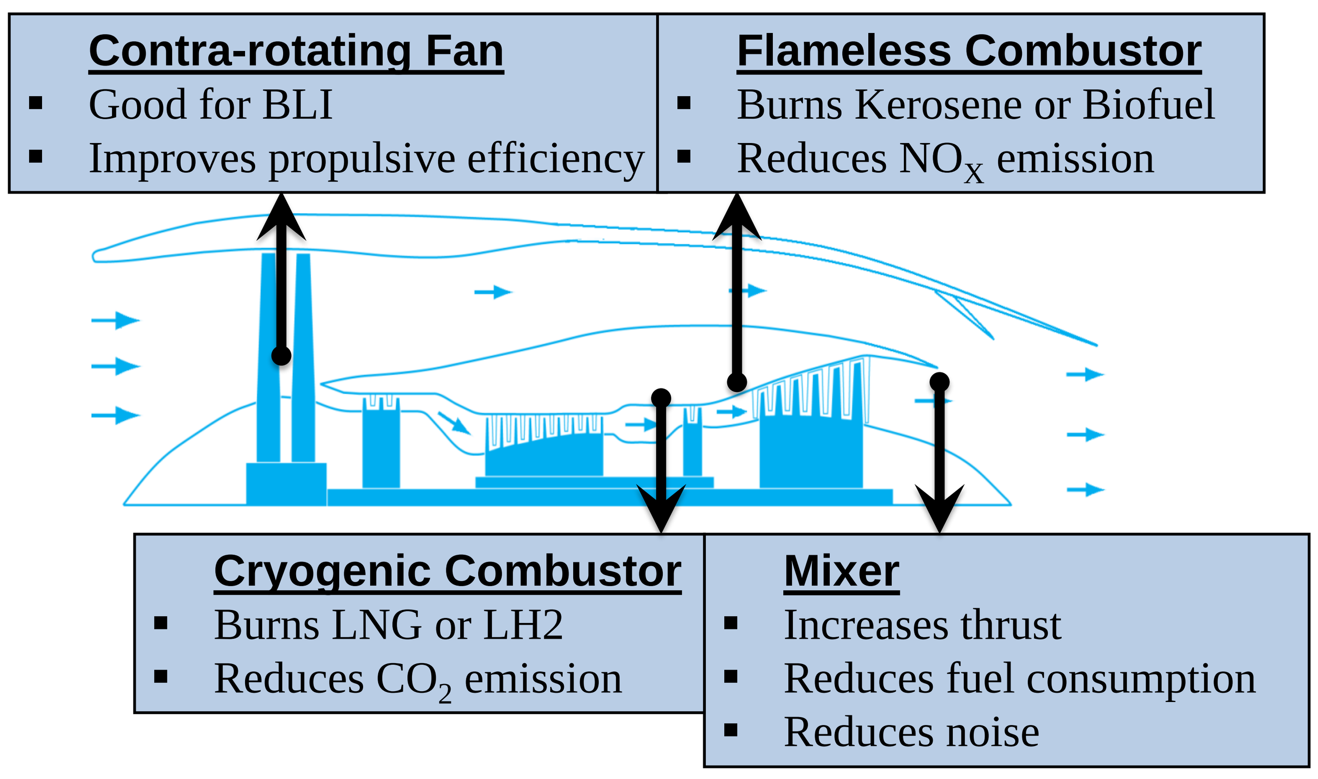

Fig. 3: Scheme of the Proposed Engine Layout

Approach

The hybrid engine model is created in Gas turbine Simulation Program (GSP) developed by TUDelft and NLR. GSP is a component-based gas turbine modeling environment, where both design and off-design can be performed. The proposed hybrid engine model in GSP is presented in Fig. 4.

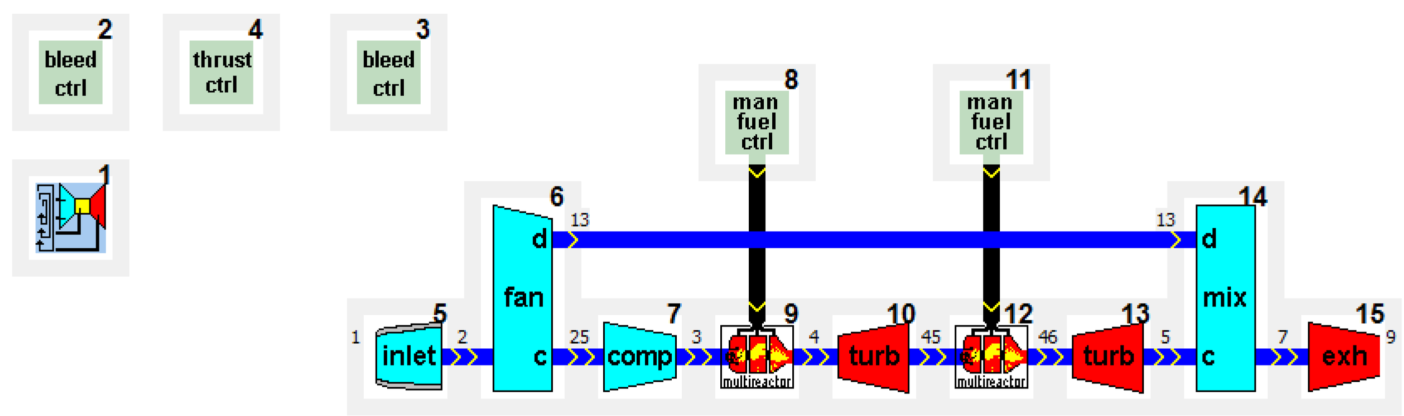

Fig.4: GSP model of Proposed Hybrid Engine

The Hybrid Engine Cycle Study

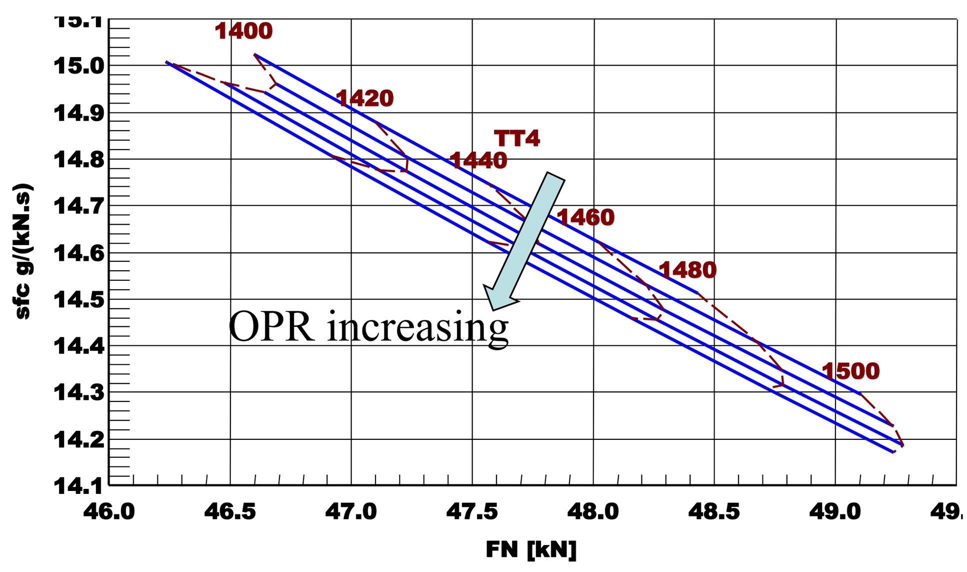

Fig.5 shows a carpet line of the Specific Fuel Consumption (SFC) and Net Thrust (FN) with respect to High Pressure Turbine Inlet Temp. (Tt4) and Overall Pressure Ratio (OPR)

Fig.5: hybrid engine cycle parametric study

Fig.6 shows a carpet line of SFC and FN with respect to low pressure turbine inlet temperature (Tt46) and OPR

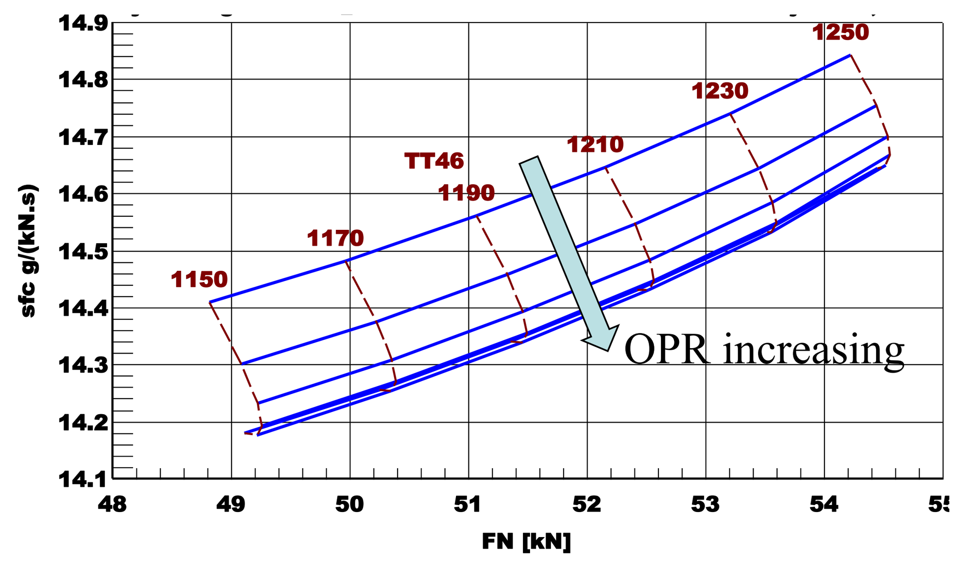

Fig.6: hybrid engine cycle parametric study

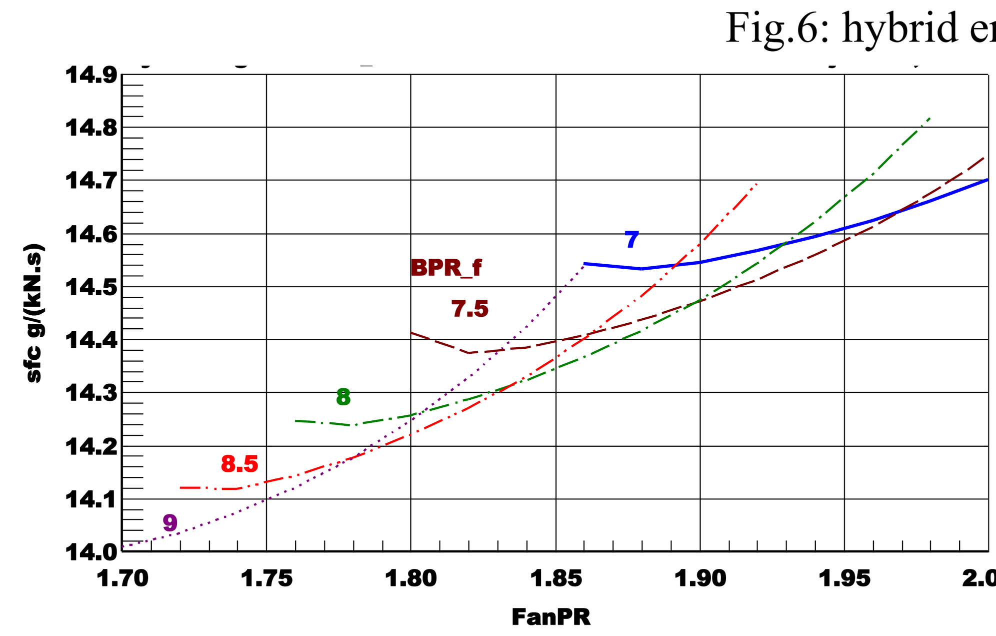

Fig.7 presents variations of SFC with respect to Fan Pressure Ratio (FanPR) for various Bypass Ratio (BPR)

Fig.7: variations of sfc w.r.t. BPR at various FanPR

Results

Genetic algorithms (GAs) has been chosen for optimization of engine design parameters at cruise. A comparison of Specific Thrust (ST), SFC (kerosene equivalent) and CO_2 emission at design point between hybrid engine using LNG and LH2 with respect to baseline engine (PW4056) can be seen in Fig.8.

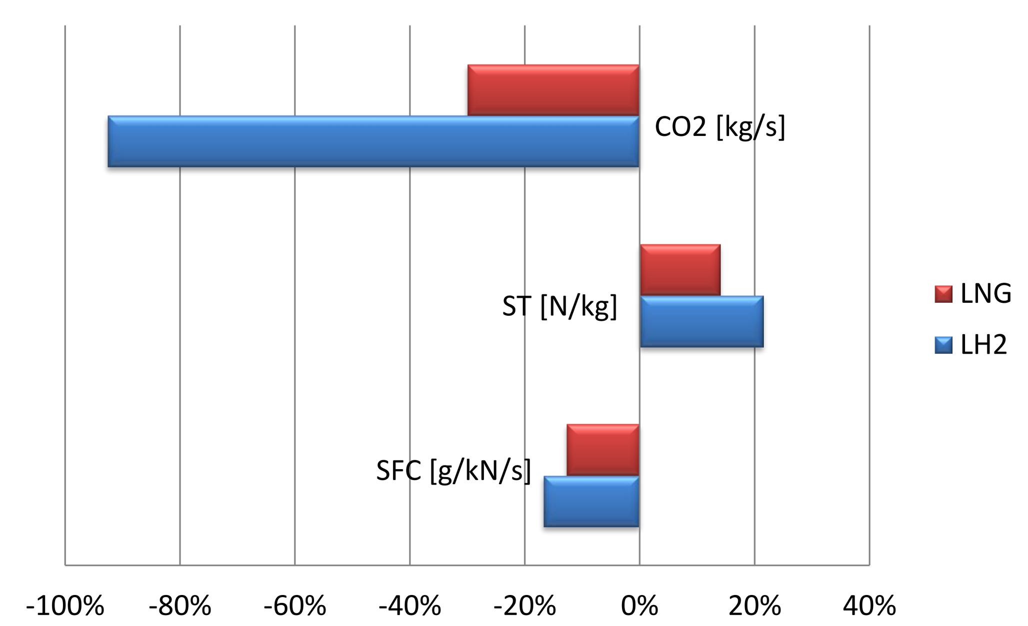

Fig.8: comparison of hybrid engine with baseline engine

It can be observed that the proposed hybrid engine shows the potential in reducing the CO2 emissions and SFC.

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