Light Helicopter Demonstrator with HCE (High Compression Engine)

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Agenda

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Engine key characteristics

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Project Overview

Project launched in the frame of Cleansky Green RotorCraft (GRC) Integrated Technology Demonstrators (ITD)

- Environmental targets
  - For H120 HCE Demonstrator, Airbus Helicopters committed on -30% Specific Fuel Consumption (SFC)

HIPE 440 Partners selected after successful Call for Proposal in February 2011
- TEOS: mechanical design, engine main parts manufacturing, assembly and testing
- AustroEngine: FADEC and harness, fuel system, airworthiness

Key dates
- KOM
- First engine run on engine bench
- Iron bird
- Ground run
- Maiden Flight

June 2011
March 2013
Oct 2013 – Feb 2014
Feb – Mar 2015
H2/2015

The research leading to these results has received funding from the European Community’s Seventh Framework Programme (FP7/2007-2013) for the Clean Sky Joint Technology Initiative under grant agreement n° CSJU-GAM-GRC-2008-001.
HCE advantages and drawback (vs equivalent turboshaft)

Advantages
• **CO2 emission reduced** (thanks to lower Specific Fuel Consumption) by minimum 30% and **up to 50%**
• **Performance maintained in hot** temperature and **high** altitude thanks to supercharging, whereas performance are continuously decreasing with air density for turboshafts
• **Direct Operating Costs lowered** (including fuel and maintenance)

Drawback:
• **Heavier** engine
  → need for brand new engine with installed mass/power ratio below 0,8kg/kW
Engine key characteristics

Components and material description
• 8 cylinders in V, 4.6L capacity, 90° angle
• Fueled with Kerosene (Jet-A)
• Fully machined aluminium blocks (cylinder head, crankcase, timing drive casing…)
• Fully machined titanium conrod
• Steel pistons and liners
• Common rail direct injection (1800bar)
• Supercharged (1 turbo per cylinder bank)
• Liquid cooled
• Dual channel FADEC controlled
• Starter and generator

Mass of Core engine dry = 197kg

Installed Powerpack for serial lower than 0,8kg/kW
Achievements
Achievement #1: Fuel consumption

Engine bench test results

GRC7 assessment

Specific fuel consumption (g/kW/h) vs power output (kW)

Calculation done by Cranfield University, at iso Payload (extract)

<table>
<thead>
<tr>
<th>Passenger Fuel Economy</th>
<th>HCE Y2020C vs SEL_U1 Y2020C</th>
<th>% A</th>
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</thead>
<tbody>
<tr>
<td>CO₂ per km</td>
<td>-62.08</td>
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<tr>
<td>NOₓ per km</td>
<td>-34.15</td>
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- Different mission profiles – results normalised wrt distance (44km mission range for SEL_U1 and 250km for HCE)

HCE: High Compression Engine
SEL_U1: Single Engine Light (Model 1st Update)
Y2020C: Aircrafts evolution in 2020 with Cleansky inputs

Depending on duty cycle: up to 62% fuel saving
Achievement #2: Rotor speed (Nr) control

- During Ground test, the Nr control reactivity was first evaluated too slow by Flight test crew
- Nr control parameters have been improved and approved by Flight test crew
  - Ex: collective pitch decrease

- Same applies to collective pitch increase
- This last set of parameters will be tested during Flight tests

Stable and fast Rotor speed control
Achievement #3: Torque oscillations reduction

Due to combustion principle (non-continuous) and high rotor inertia, a torque oscillations reduction device is mandatory. The chosen solution is a lightweight torsional shaft fitted in the Core Engine, acting like a low-pass filter.

Instantaneous Torque vs Crank-Angle at Crankshaft output: +/-100%!

Dynamic Torque at MGB inlet during max Power

Main Gearbox standard torque oscillations limits are respected
Achievement #4: Engine movements

Silent blocs are installed between Powerpack and Helicopter airframe in order to:
- Limit engine movements and secure link between Powerpack and Main Gearbox
- Damp vibration from Powerpack to Helicopter (and vice-versa)

Here below is an example of engine movements measured on engine front left foot during Iron bird campaign

Engine movements are very small and vibrations well damped
Conclusion

Assuming a successful test campaign, Airbus Helicopters, AustroEngine and TEOS have started discussions for possible further development and industrialization of this engine for Fixed-Wings and Rotorcraft use.
Thank you! Any question?