Assessing the climate impact of a multi-fuel blended wing body: Results from the AHEAD EU-project

Grewé, V., Bock, L., Burkhardt, U., Gierens, K., Unterstrasser, S., DLR-Institut für Physik der Atmosphäre, Oberpfaffenhofen


Motivation
Future (2050+) aviation faces various challenges, such as
- Mitigation of climate change (ACARE goals)
- Fuel supply

EU-project AHEAD
In the AHEAD EU-project, we addressed these open questions by investigating a multi-fuel blended wing body:

Tools and Methods
Contrail formation
Adapted Schmidt-Appleman Criterion; Mixing Slope G in the H2O-T phase diagram

Properties of the early contrail
Large-Eddy Simulations to determine contrail depth and ice crystal numbers
⇒ Contrail depth similar, but ice crystal number lower for LH2-fuel

Contrail-Cirrus
Climate model with contrail-cirrus parametrisation (2-moment-scheme)

Climate impact assessment
Reference: Future - B777-200ER
Scenario: EIS 2050 Full fleet: 2075
Average Temperature Response Time Horizon: 2050-2150

Climate impact
Climate-chemistry response model AirClim was adapted and used to estimate the impact of MF-BWB on climate

Climate Impact Assessment
Left: MF-BWB with LNG reduces the longterm climate impact by roughly 20 to 25% compared to conventional technology.
Less NOx and contrail impacts
More H2O impact

Conclusions
- Two combustion chambers
  - LNG / LH2
  - Biofuel burnt in hot and vitiated environment
⇒ Flameless combustion with very low NOx and CO emissions
- Successfully tested at test-rigs

Engine and aircraft
- Similar size and range as conventional a/c e.g. B777-200ER
- LNG and LH2 can be stored in the rear and biofuels in wings

Trajectories and Emissions

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Further reading:
http://www.ahead-euproject.eu/

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Conclusions
- The use of a multi fuel blended wing body has the potential to significantly reduce the climate impact from aviation.
- Most promising is the reduction in
  - contrail-cirrus climate impact (partially due to reduced ice particle number densities) and
  - NOx climate impact via ozone, methane and primary mode ozone (feedback from methane changes)
- Water vapour climate impact is enhanced by MF-BWBs
- LNG more promising than LH2, especially since production of LH2 is not considered.

Next steps:
- Analysis of atmospheric uncertainties on the results.
- Engine integration, Boundary Layer Ingestion, …

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