The Potential Benefits of Alternative Aviation Fuels with High Thermal Stability

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Research Objective: To locate a global optima for sustainable aviation fuels to maximize performance benefits from thermal stability and energy content within the set of bounds defined by ASTM.

Motivation

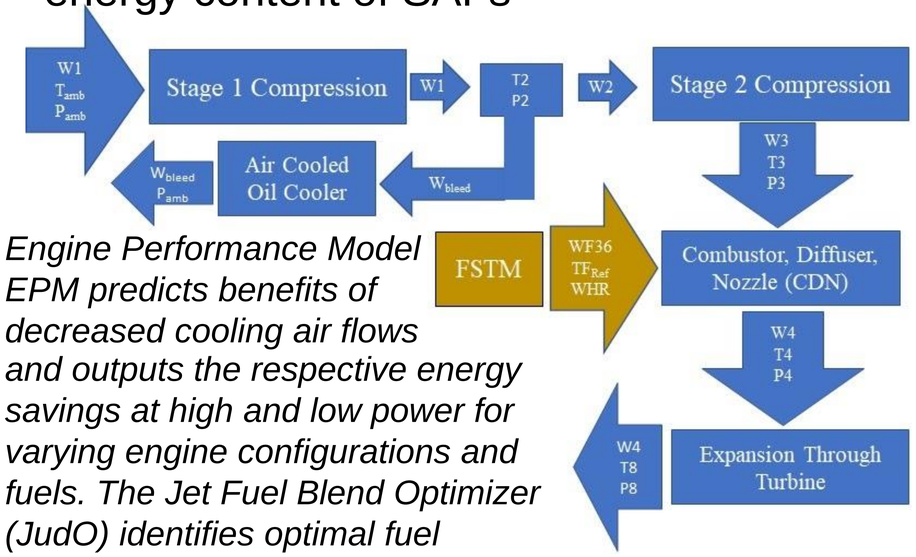
- Global carbon emissions from aviation have been calculated to make up 3.5% of the net anthropogenic gas radiative forcing[1]
- current research shows levels of anthropogenic emissions generated by combustion systems are one of the leading contributions to global climate change[2]
- One technique that provides a near term solution to minimizing greenhouse gas emissions is sustainable aviation fuel (SAF)

Performance vs. Operability

- SAF adoption is guided by approval process (ASTM D4054) outlining comprehensive testing & review
- SAF properties such as total energy content and thermal stability can add value and performance benefits
- Specifically, increased thermal stability of SAFs can decrease specific fuel consumption and maintenance costs

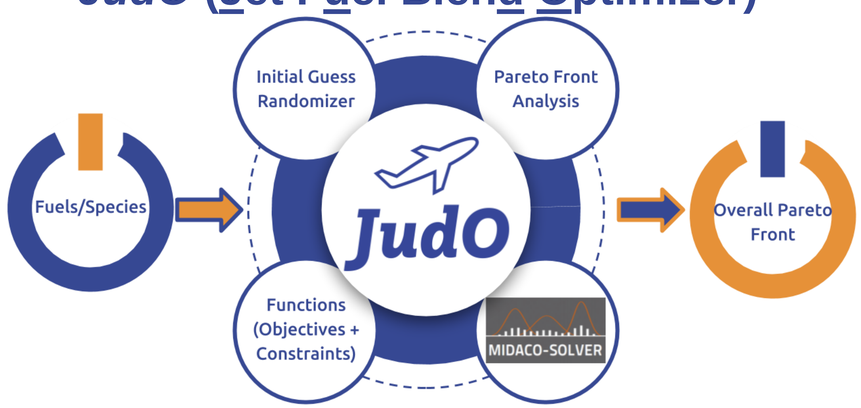
Methodology

- Leverage Engine Performance Model (EPM) with the Jet Fuel Blend Optimizer (JudO) to identify fuel compositions that simultaneously maximize both thermal stability and total energy content of SAFs



Engine Performance Model EPM predicts benefits of decreased cooling air flows and outputs the respective energy savings at high and low power for varying engine configurations and fuels. The Jet Fuel Blend Optimizer (JudO) identifies optimal fuel composition for varying performance metrics

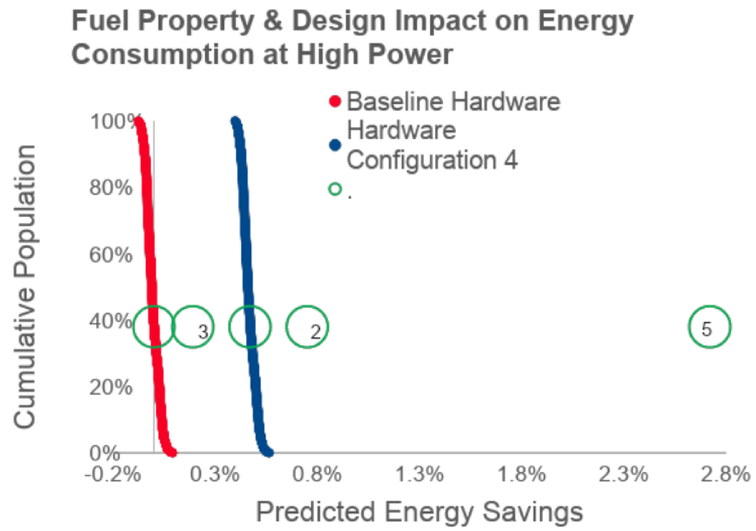
***JudO* (Jet Fuel Blend Optimizer)**



References

1. CAAFI. Sustainability, 2020.
2. Lee DS al. The contribution of global aviation to anthropogenic climate for 2000 to 2018.

Results



Preliminary results from the EPM model at high power showing the potential for increased energy savings. Each point on the red and blue line represents a SAF fuel mixture. The combination of Judo and the EPM will allow for optimized performance metric SAF blends to yield larger energy savings.

Conclusions & Future Work

- Implement the EPM and JudO simultaneously to identify optimal fuel species
- Identify novel SAFs beyond the scope of current research for potentially high thermal stability
- Further investigation into experimental thermal stability values in order to identify an increase in efficiency for thermodynamic cycles