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Alternative fuels research

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University of Sheffield



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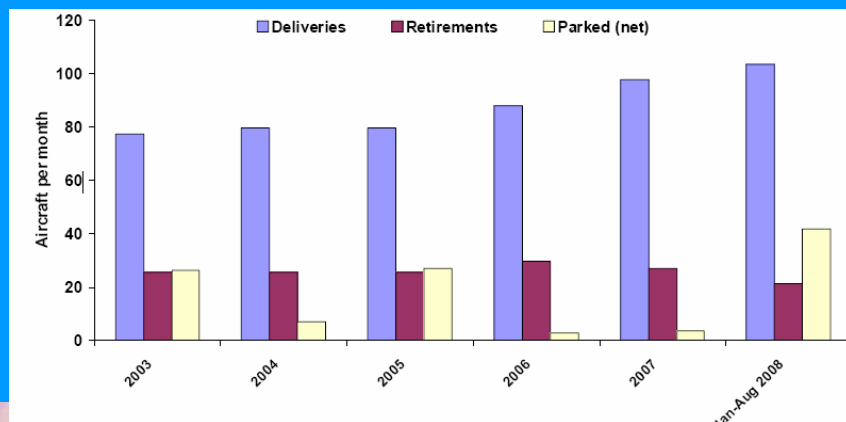
- Alternative fuels
 - Engine / Airframe Performance
 - Combustion and Emissions
 - Material Compatibility
 - Thermal Stability
 - Modelling/Simulation



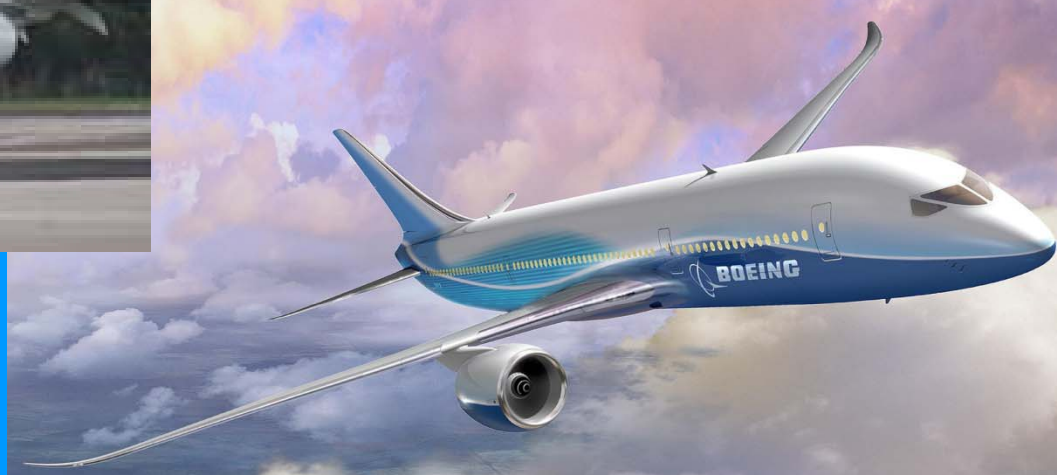
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The newest and future aircraft

1st commercial flight Oct 2007



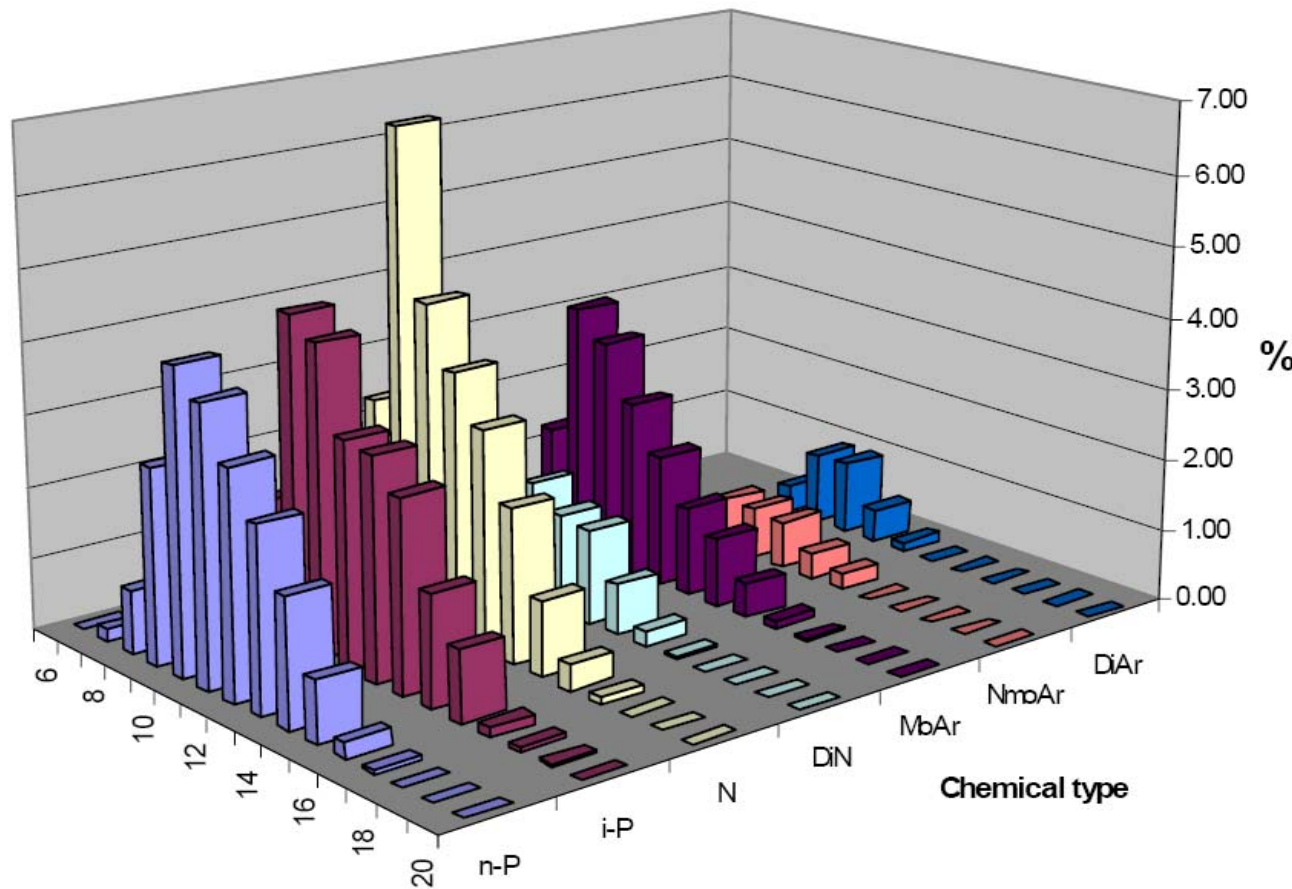
1st flight Dec 2009



Assets remain in use for upwards of 40 years!

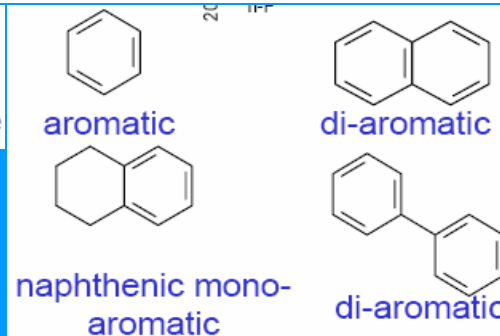


Typical Jet fuel composition



Typically

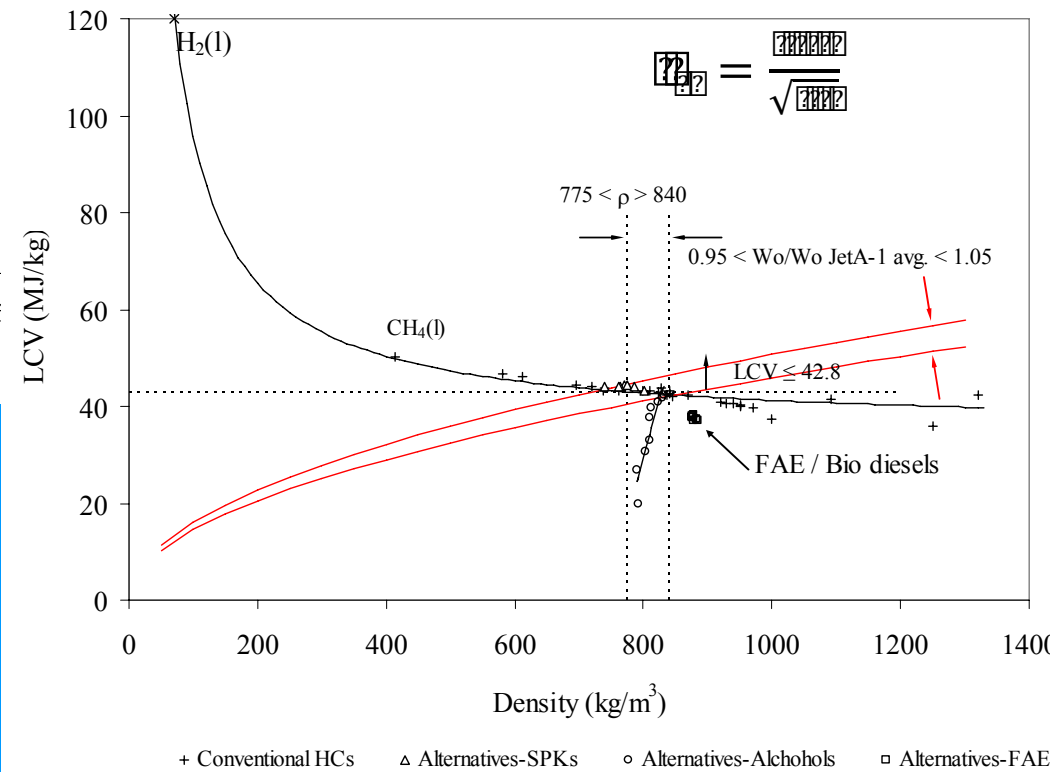
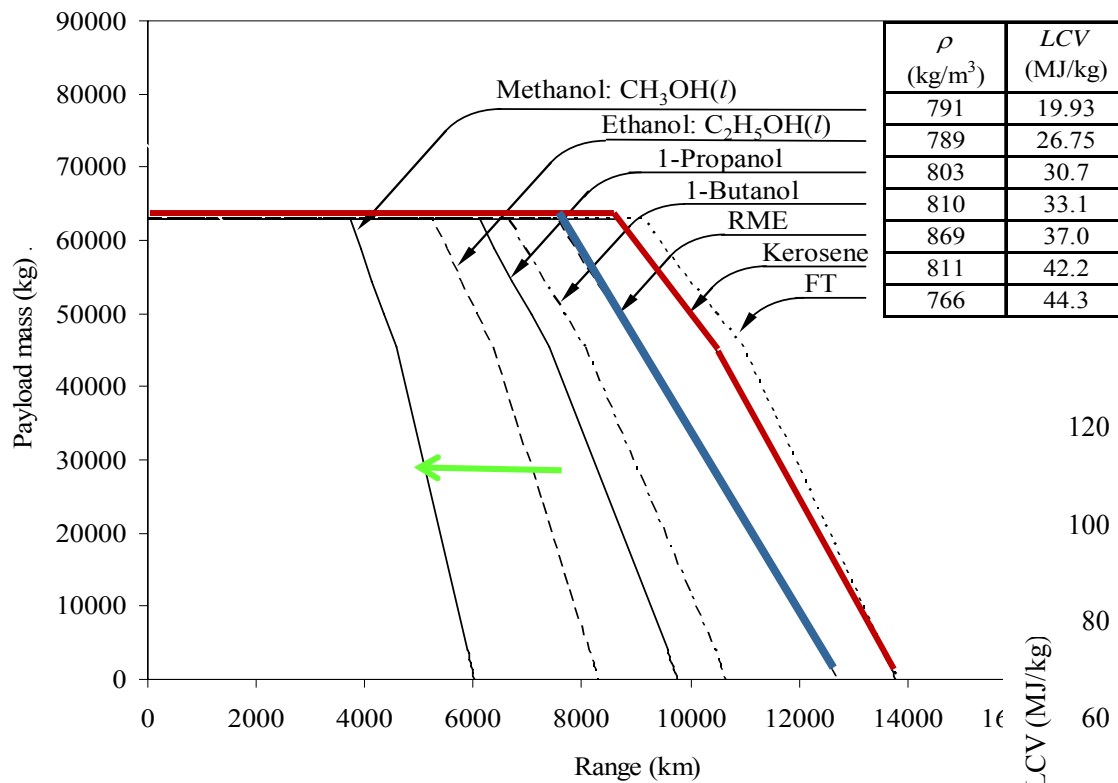
- C8-C16
- 70-85% paraffins
- Normal/iso/cyclic split dependant on crude
- Cyclo reduce freeze point
- <25% aromatics
- Trace amounts of hetroatoms Sulphur, nitrogen and oxygen





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Range Payload and suitability





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Combustor performance and emission



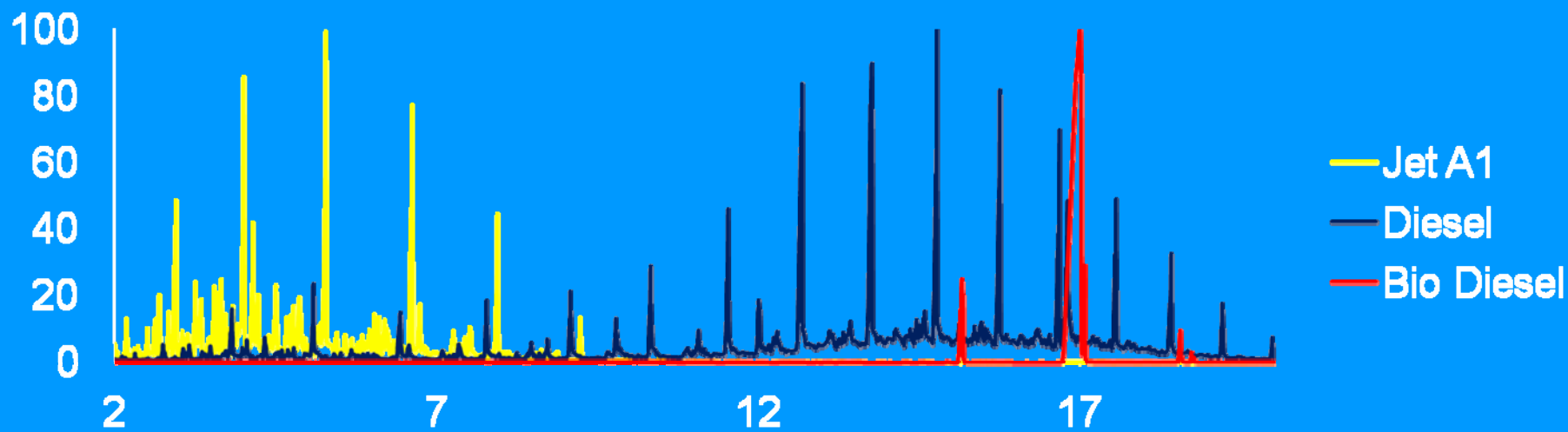
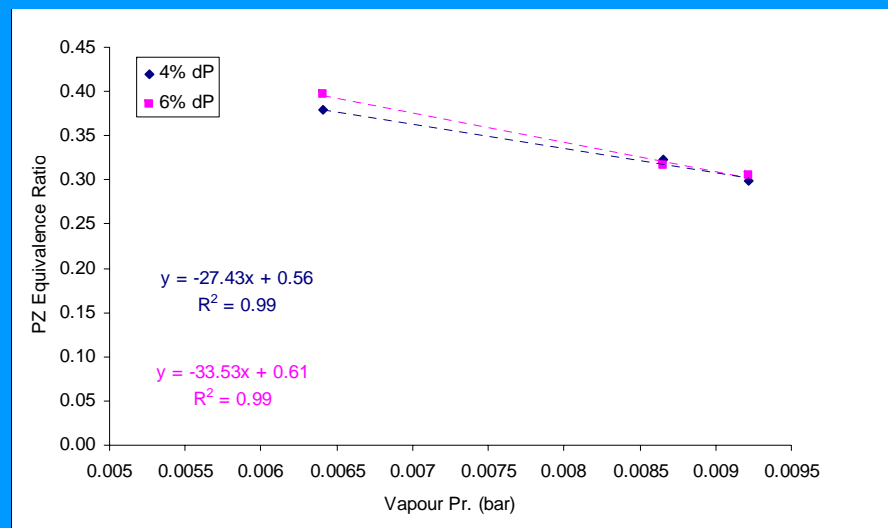
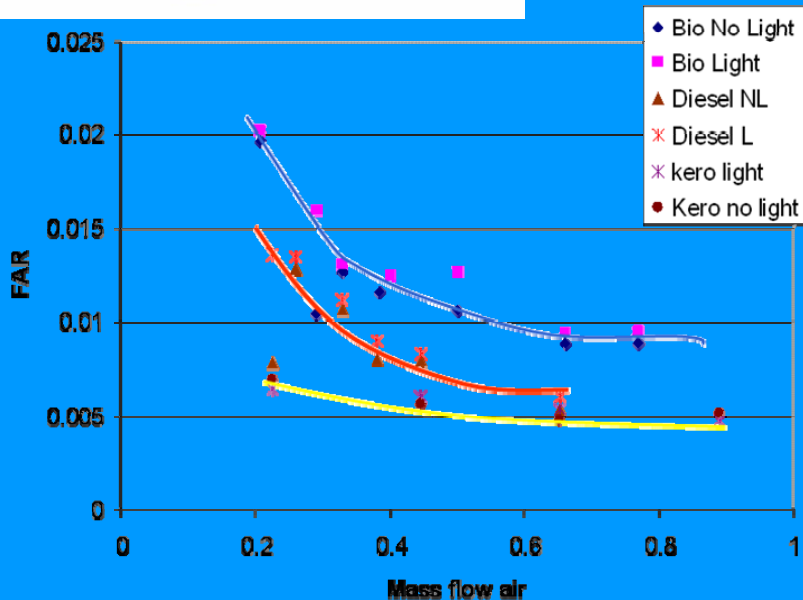
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Ignition



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Ignition performance

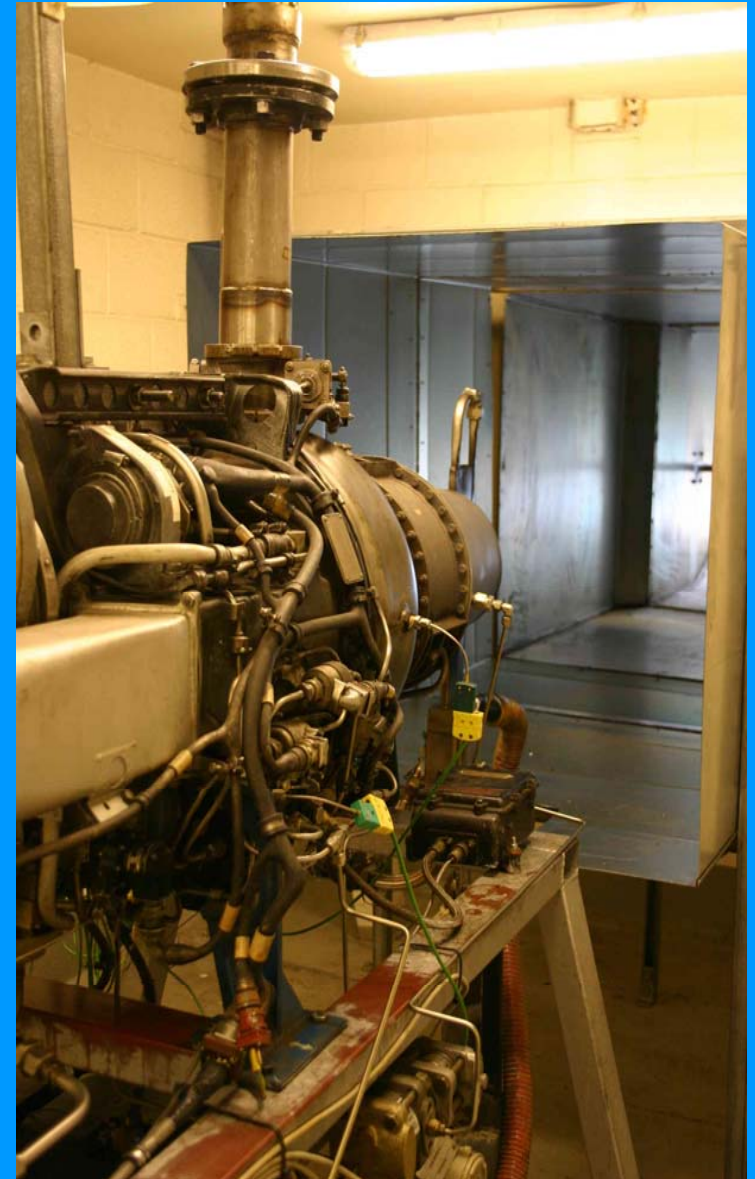




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APU engine tests

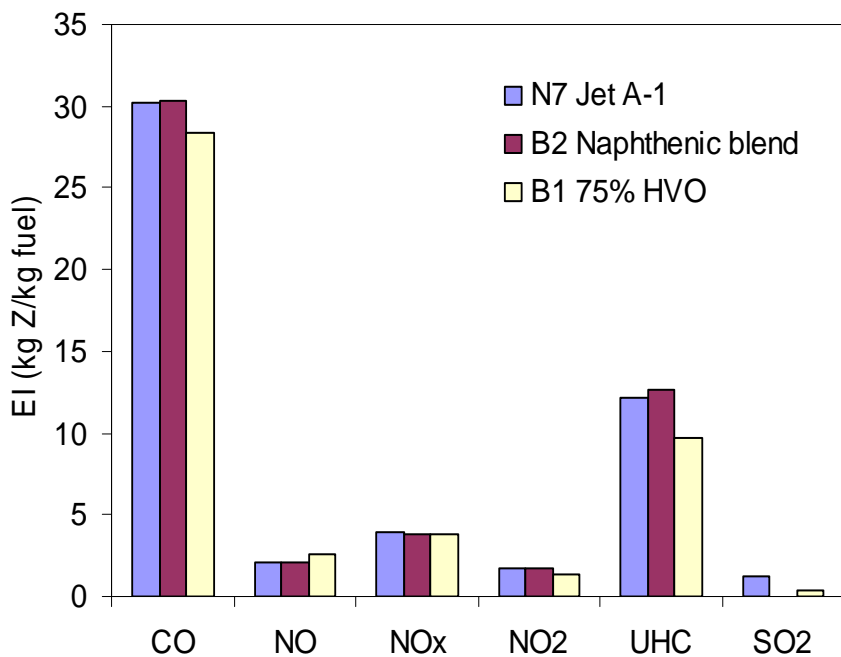
- Tested
 - Range of Jet A1, HVO's, GTL's, Blends
 - Full power, 2x idle
 - Emissions analysis, some PM and FTIR analysis





APU test: Emissions data

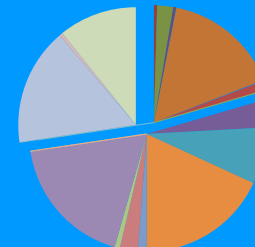
Full Power



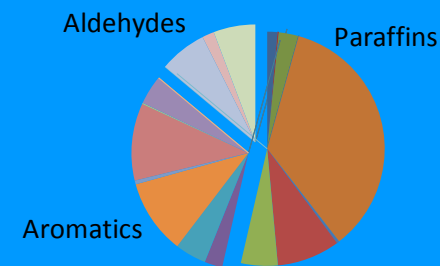
Cold idle
N7 - Jet A-1#1



Full power



Hot idle



R7 - 50% HRI/50% Jet A-1#2

Paraffins

- Methane CH4
- Ethane C2H6
- Propane C3H8
- Pentane C5H12
- Hexane C6H14
- Heptane C7H16
- Acetylene C2H2
- Ethylene C2H4
- 1,3-Butadiene C4H6

Aromatics

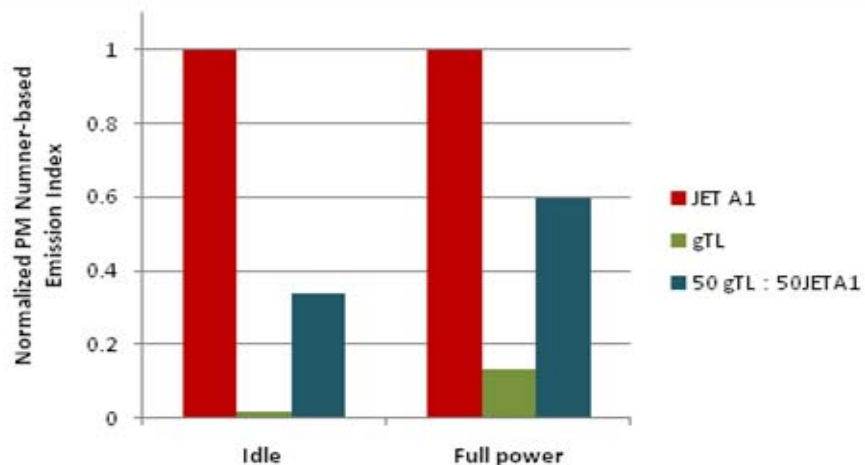
- Benzene
- Toluene
- m-Xylene
- o-Xylene
- p-Xylene
- 1,2,3-Trimethylbenzene
- 1,2,4-Trimethylbenzene
- 1,3,5-Trimethylbenzene
- Naphtalene

Aldehydes

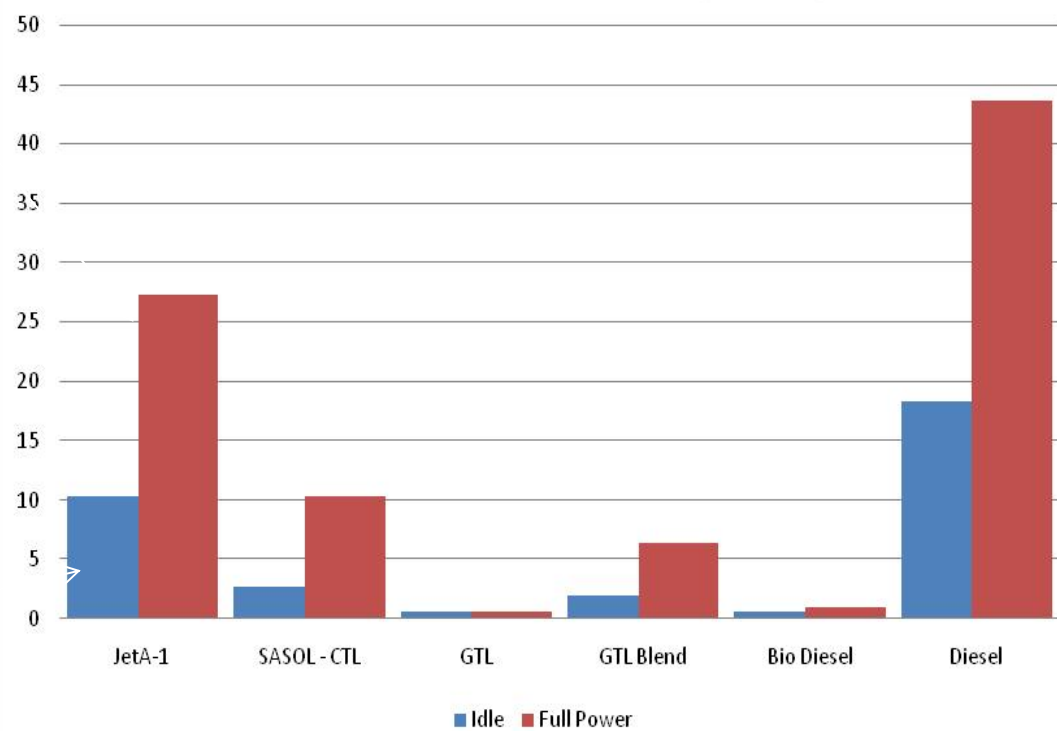
- Formaldehyde
- Acetaldehyde
- Acrolein



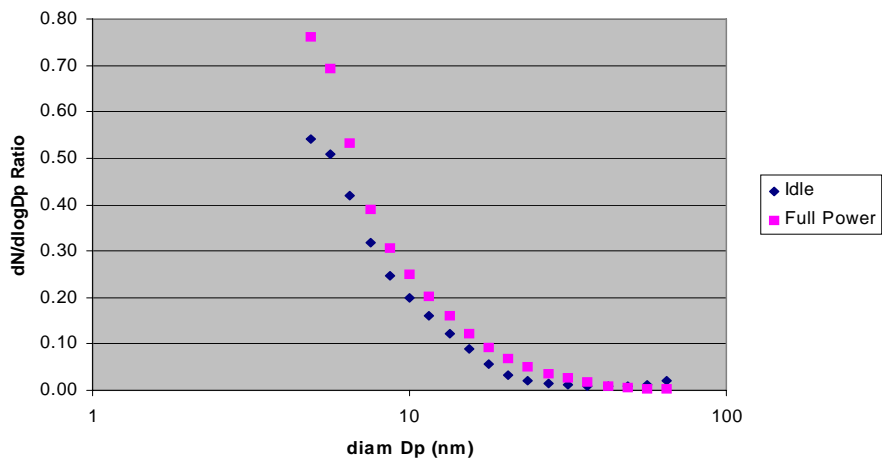
Combustion of GTL -Particulate measurements



APU Smoke Measurements (SAE SN)



Normalized size distribution for gTL





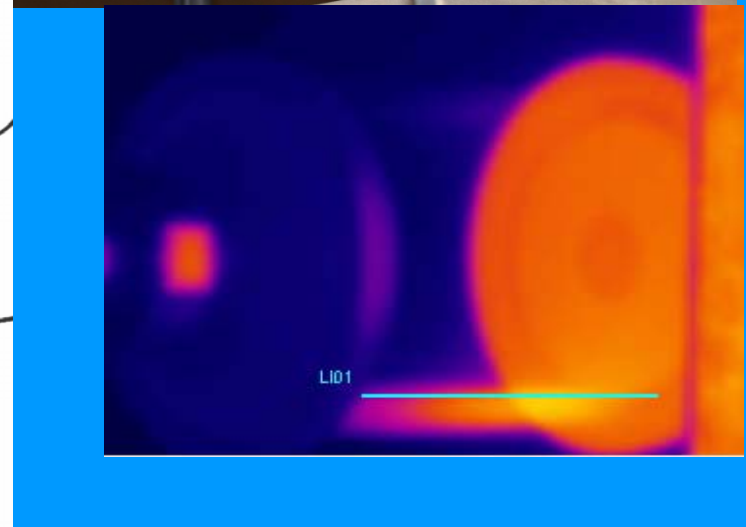
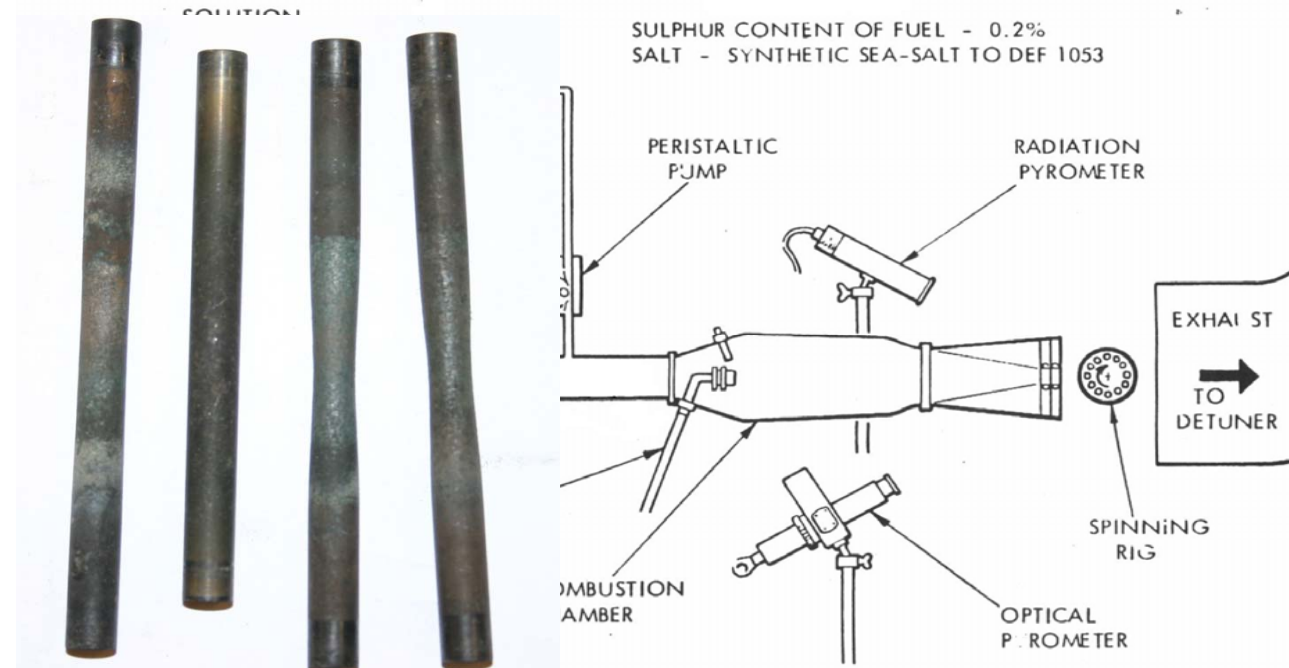
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Materials Compatibility



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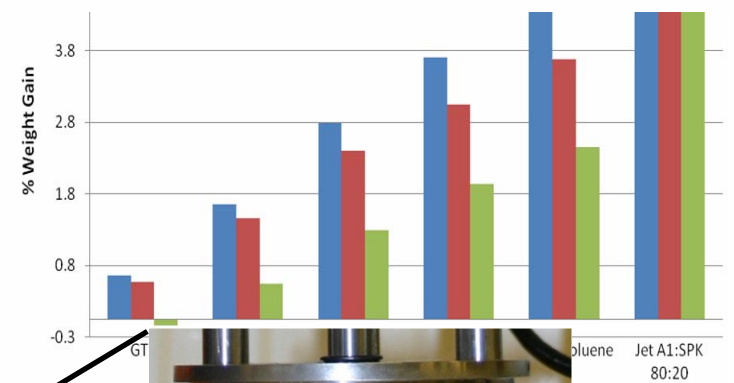
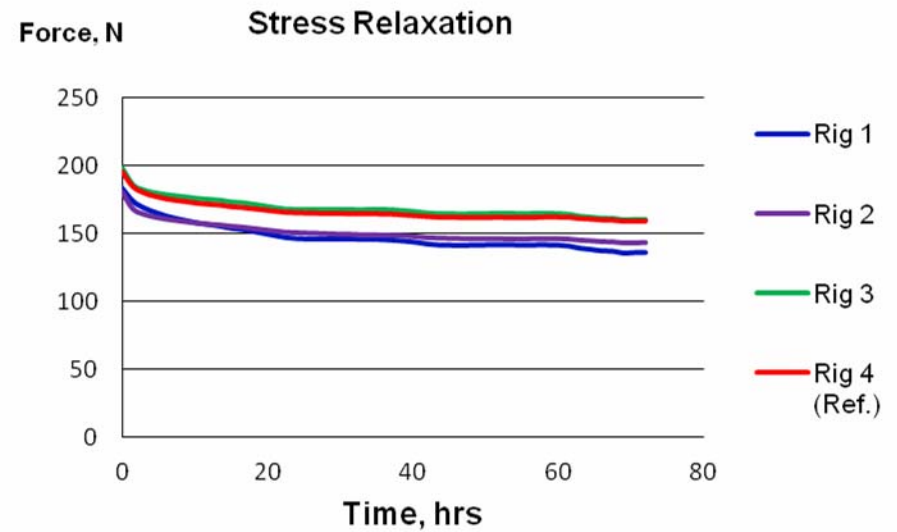
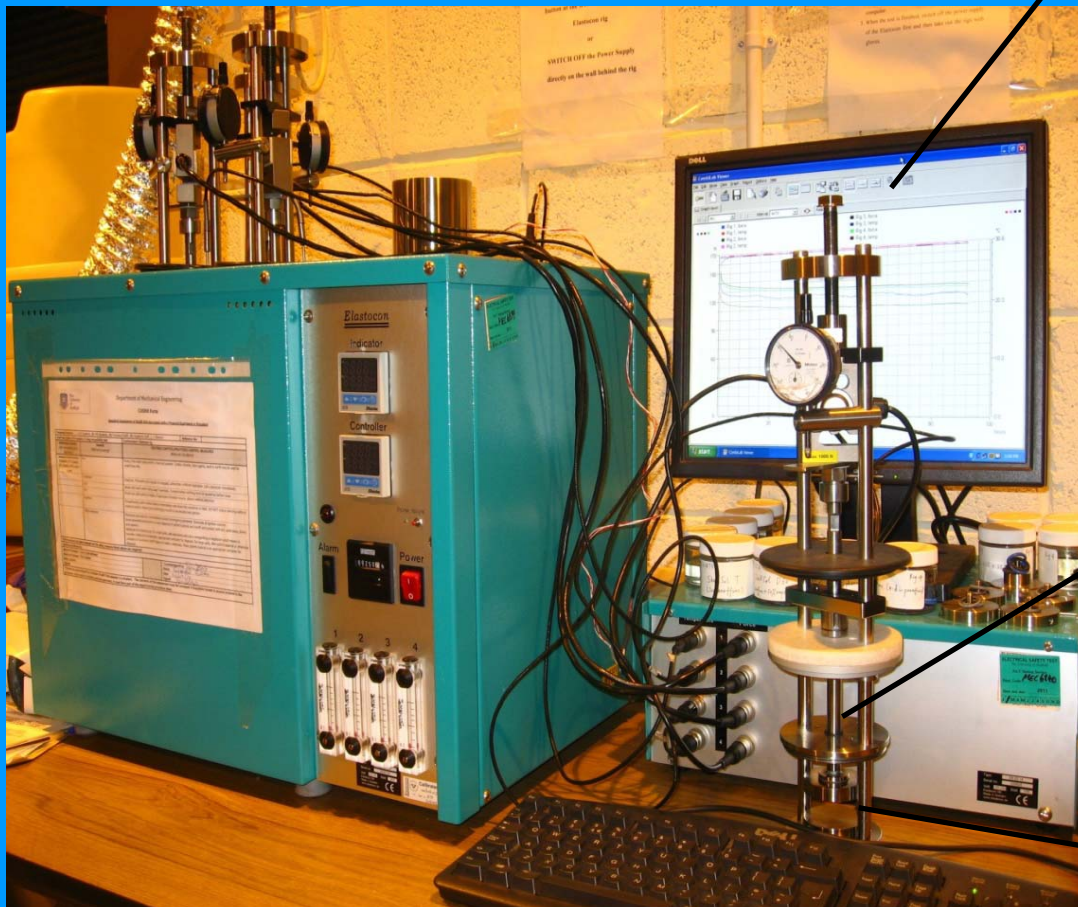
Hot End Materials Rig (HEMR)





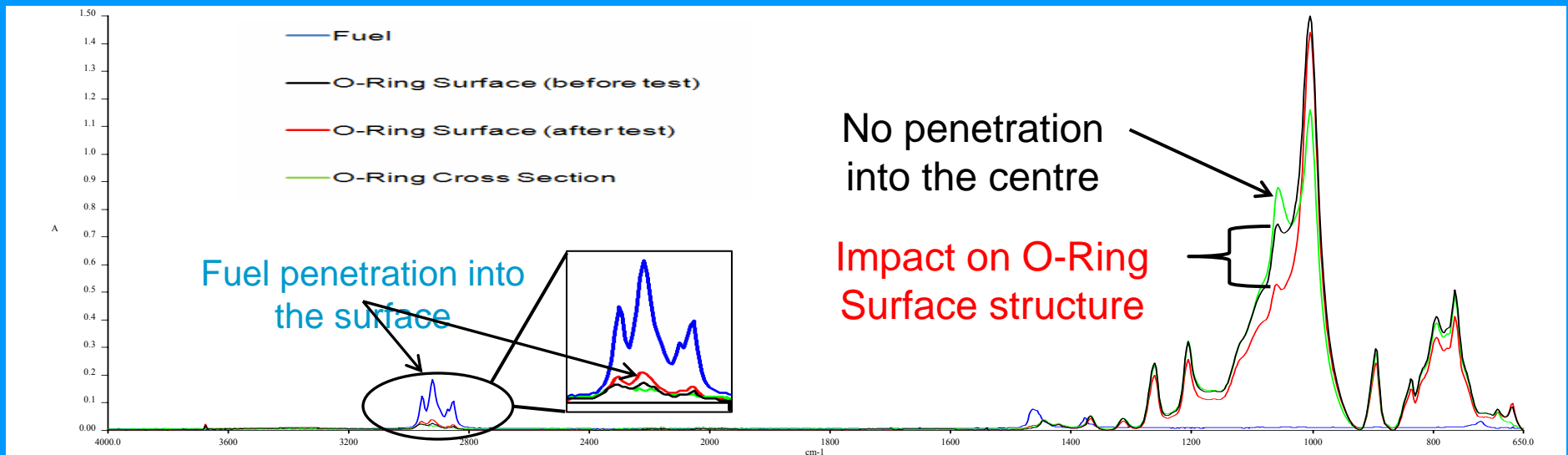
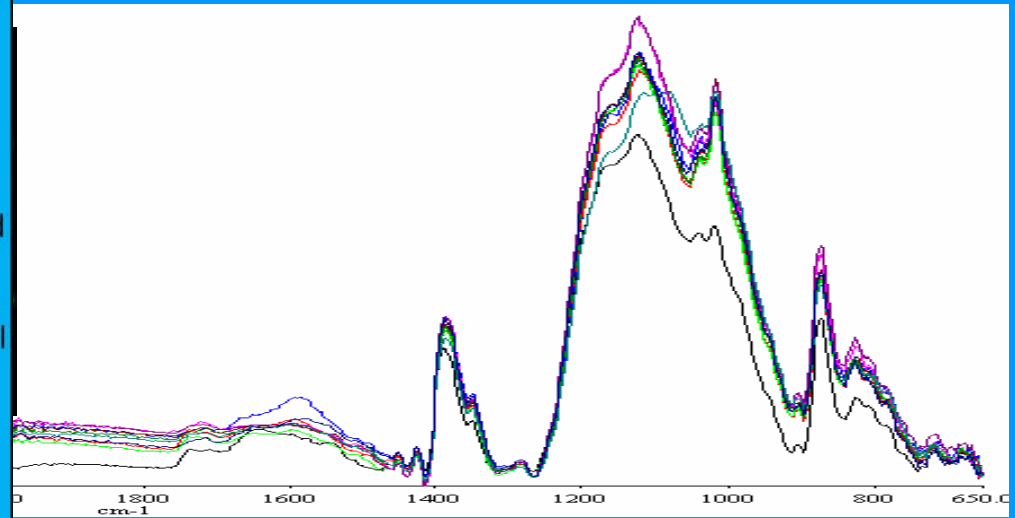
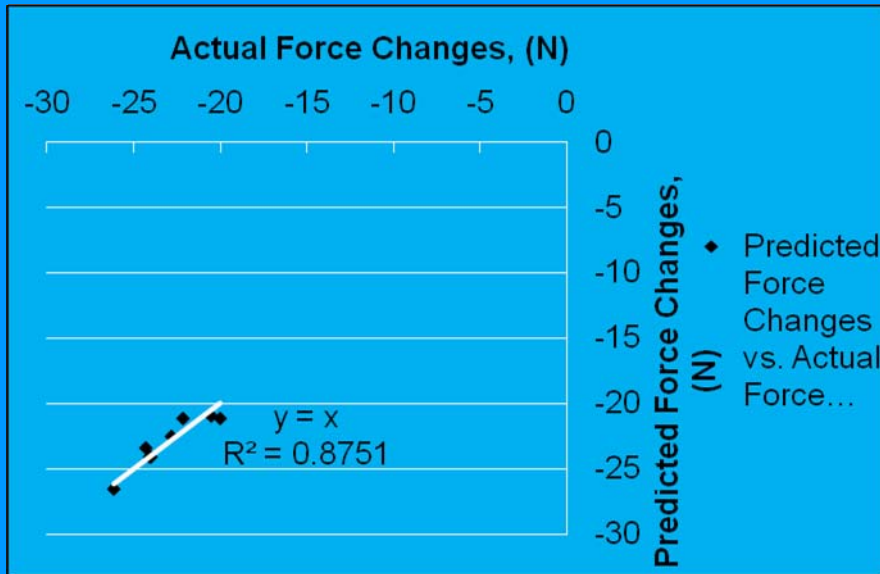
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Elastocon – Stress Relaxation





FTIR Analysis





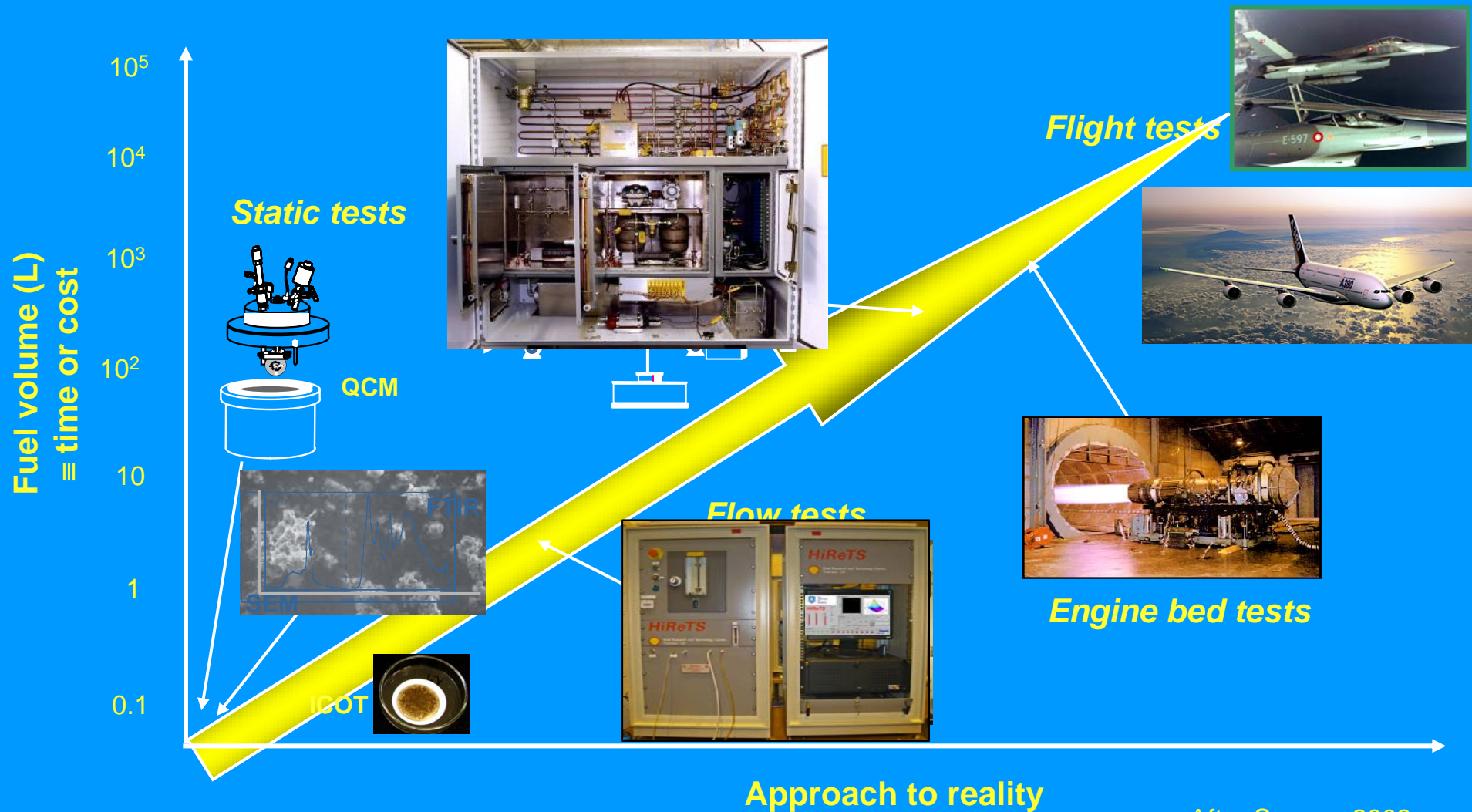
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Thermal Stability



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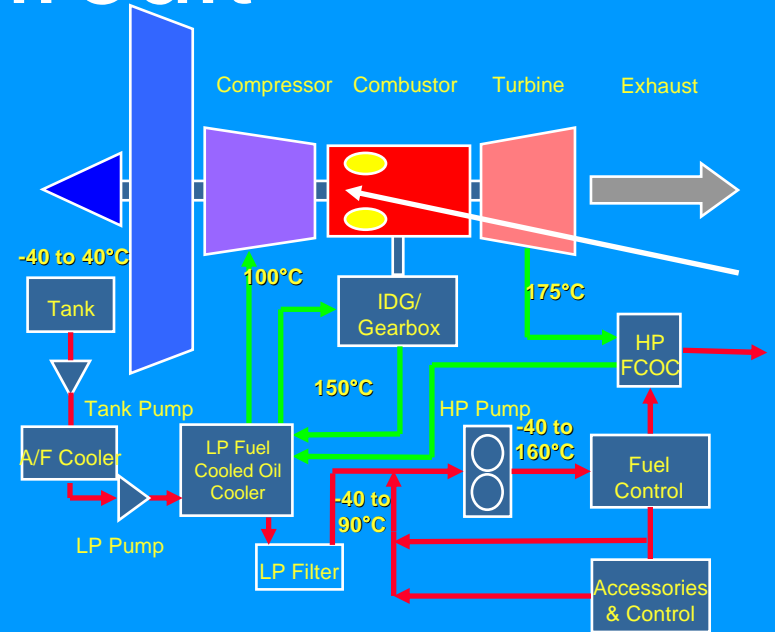
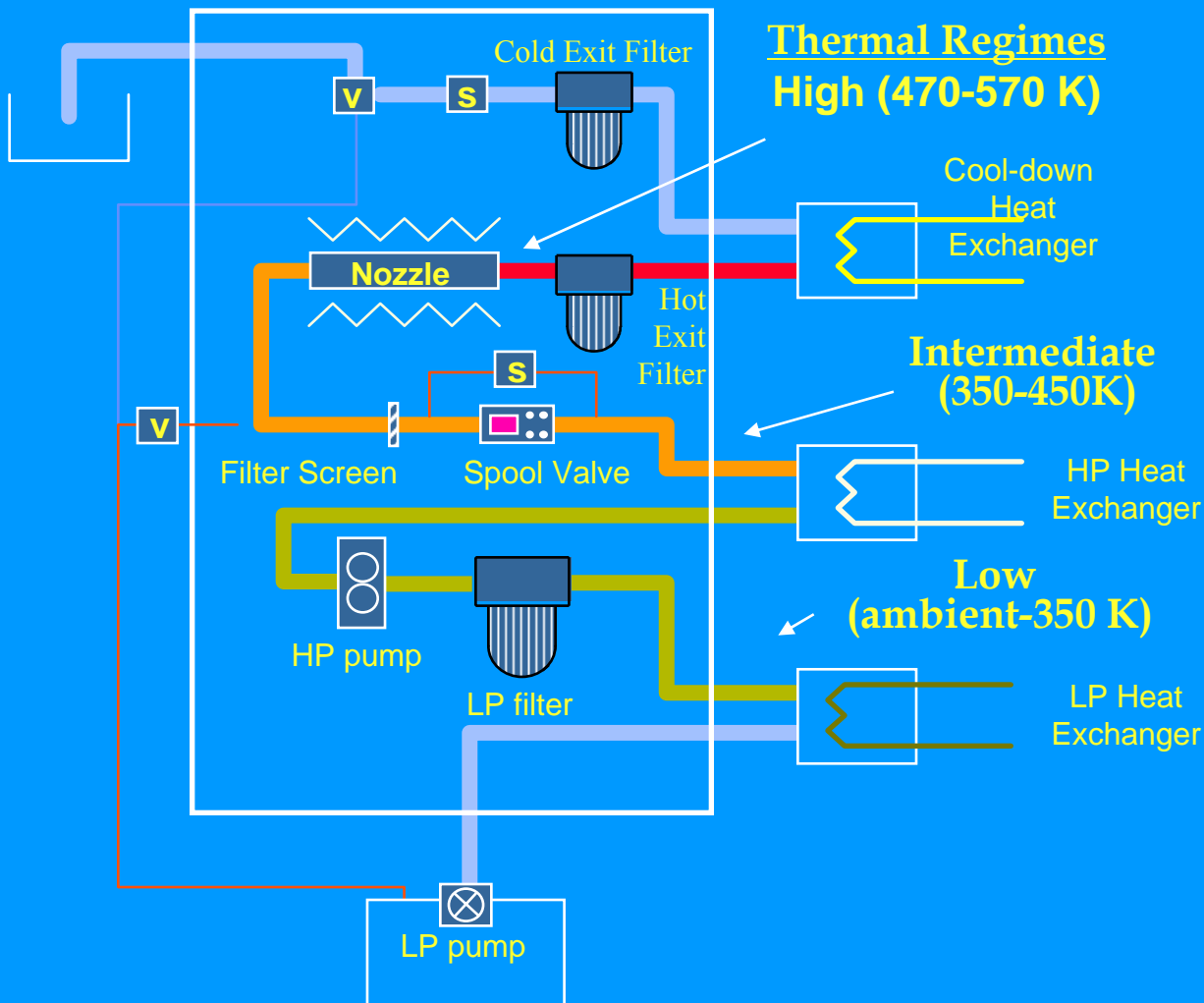
Experimental



After Spence 2003



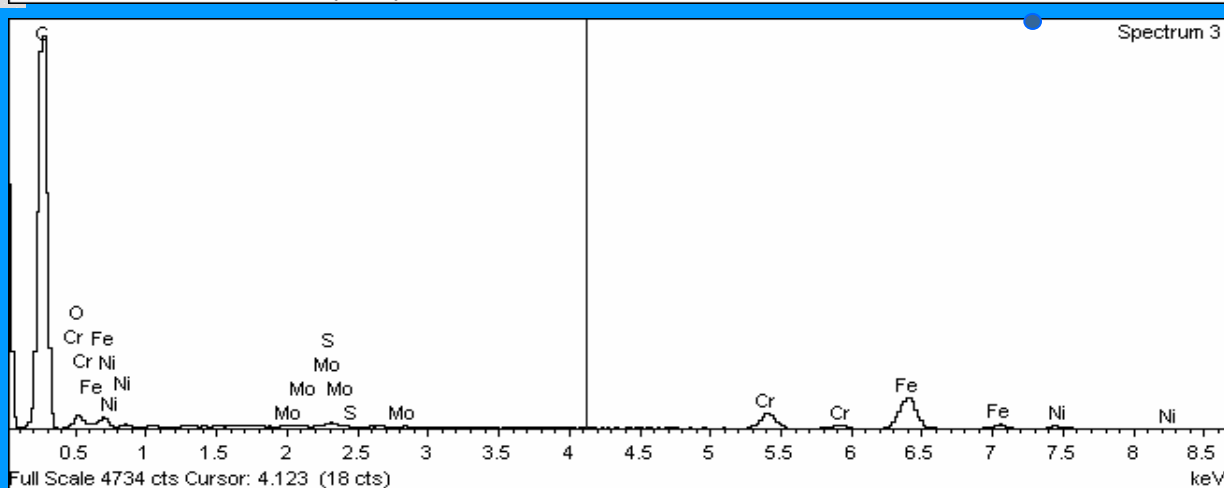
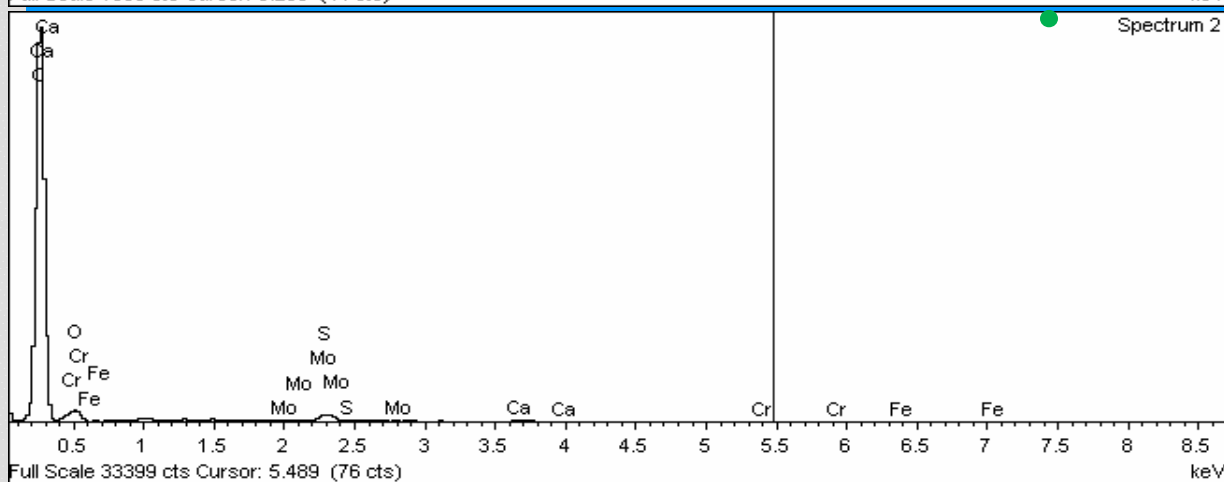
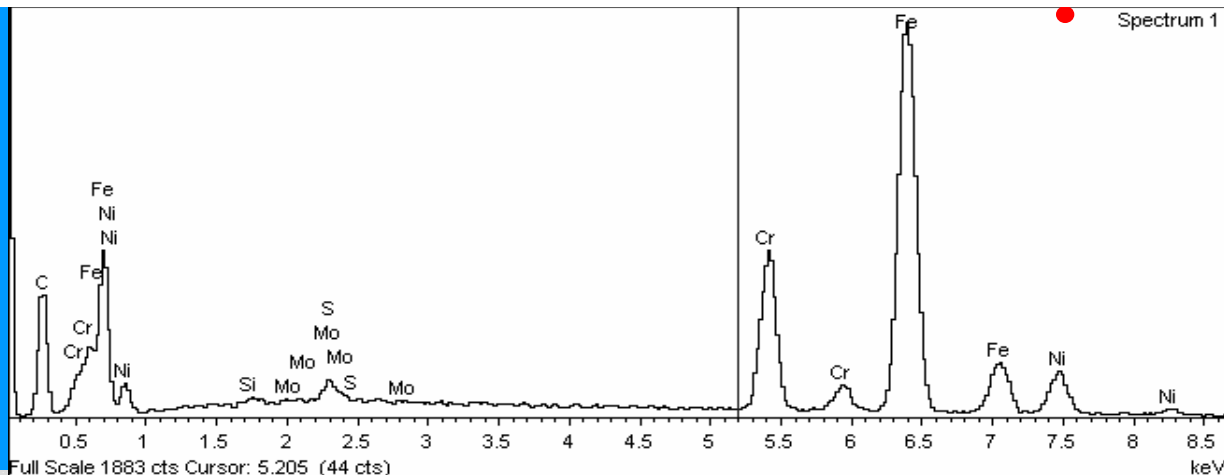
Fluid Flow Circuit





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Results of Energy-Dispersive X-ray Spectroscopy



Acc.V Magn Det
20.0 kV 1500x SE M1

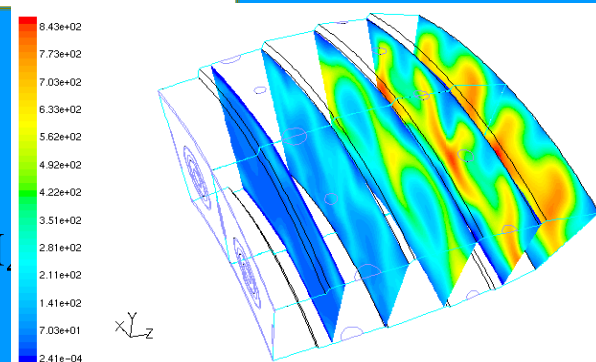
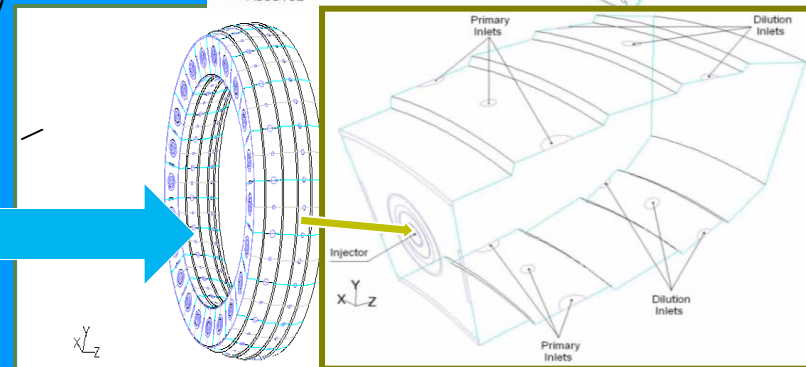
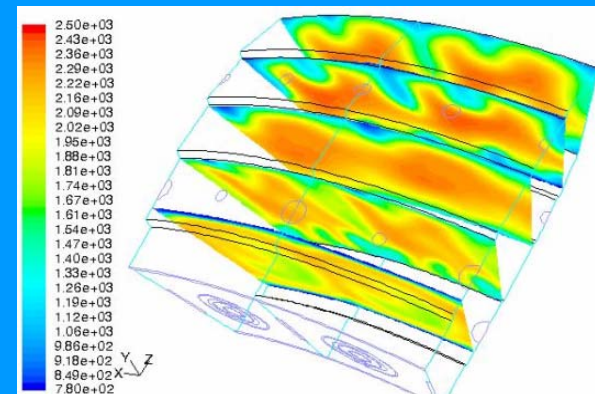
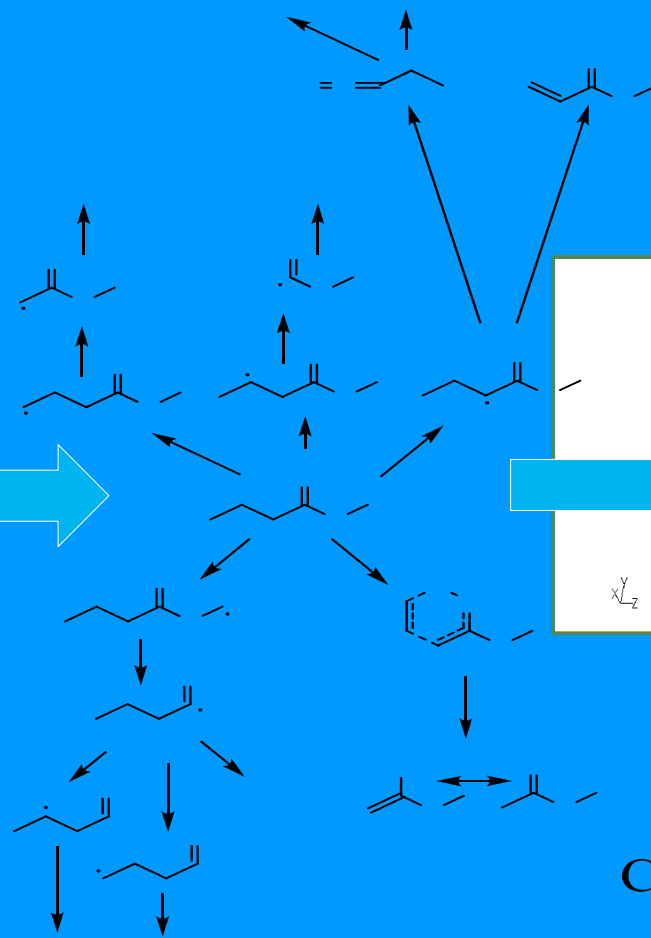
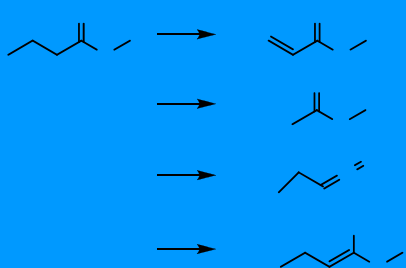
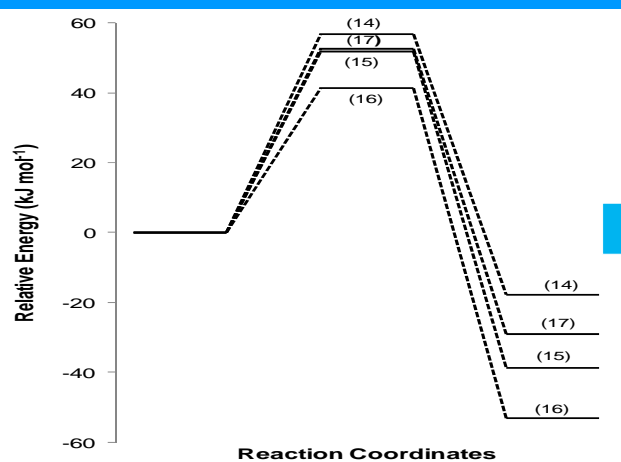
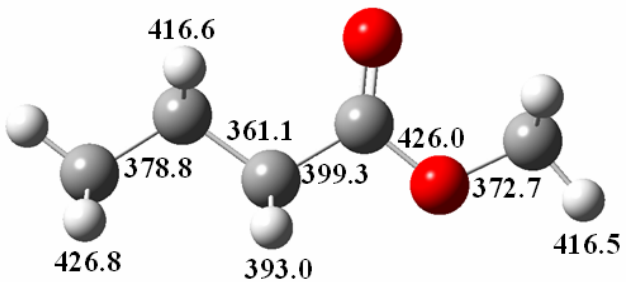
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Modelling



Multi-Scale Simulation Science

Bio (SPK) fuel
Combustion
Performance

(a)

(b)



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Any Questions