Actively Cooled Venus Lander Instrument Payload Using a Multi-Cascade Refrigeration Cycle

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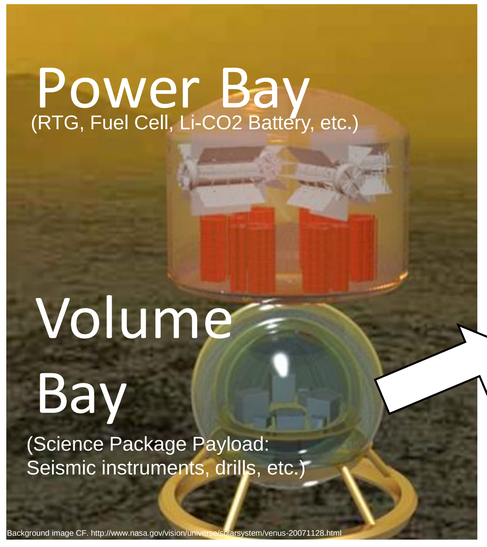
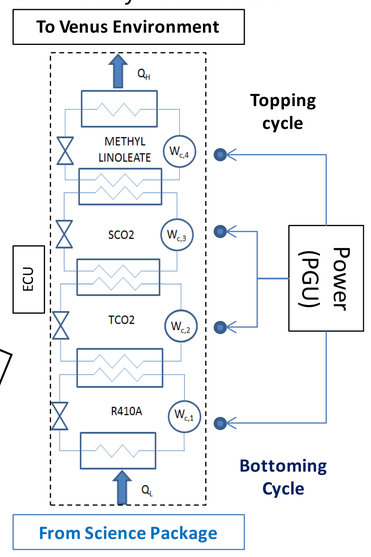
Background

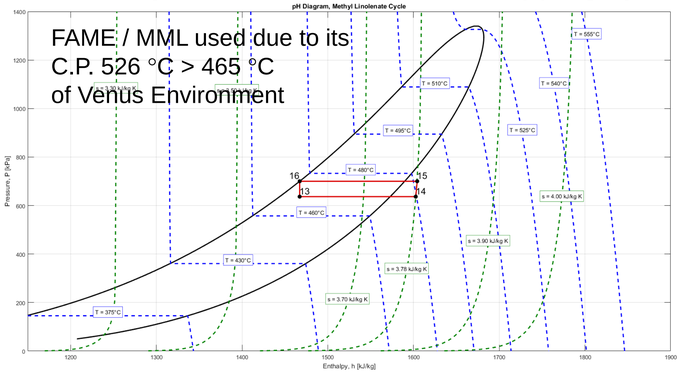
- Use of a cascade refrigeration cycle to actively cool Venus Lander payload electronics to extend mission life on the harsh Venus surface



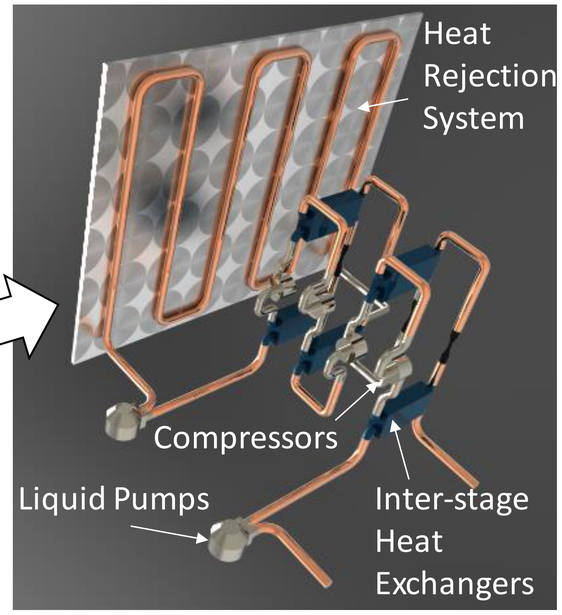
Cascade cycle schematic



- Cascade cycle is novel in its use of traditional and supercritical fluids
- NH3 bottoming, CO2 middling and Fatty Acid Methyl Ester / Methyl Linoleate FAME/MML topping cycle

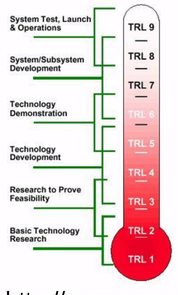


Cascade Cycle Hardware



Technology Readiness

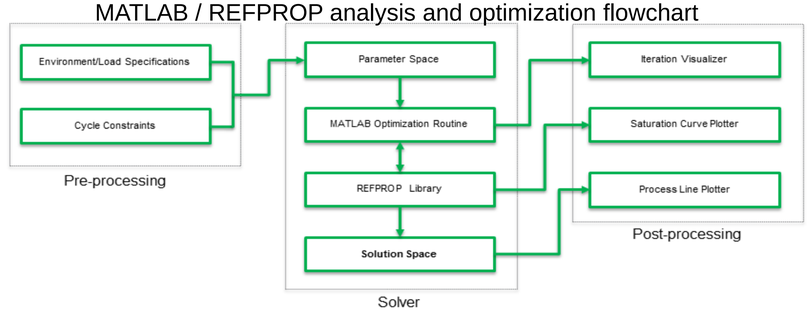
- NH3 components
  6 < TRL < 9
- Transcritical CO2 components
  6 < TRL < 7.5
- Supercritical CO2 components
  6 < TRL < 7.5
- FAME / MLL components
  1 < TRL < 3
- Need to research and develop FAME/MML compressor, seals, heat exchangers and throttling valve

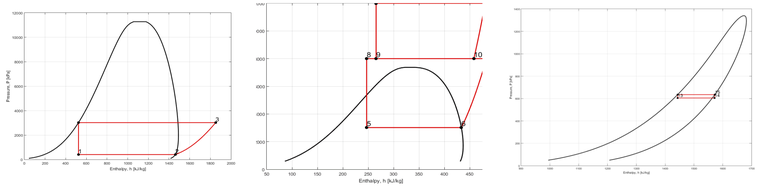


CF. http://as.nasa.gov/

Cycle Optimization

MATLAB / REFPROP analysis and optimization flowchart





PH diagrams for NH3 / TSCO2/ SCO2 / FAME MLL optimized cycles

Results

Fluid	Flow rate (kg/hr)	Compressor Power (W)
NH3	384e-3	42
TCO2	2.73	38
SCO2	3.35	21
FAME / MLL	5.63	1.4

Overall system COP = 0.98 to lift 100 W of electronics power dissipation @ 100 °C