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Pyrolysis of residues from well-established biochemical processes for biomass conversion into liquid fuel

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PYROLYSIS OF RESIDUES FROM WELL-ESTABLISHED BIOCHEMICAL PROCESSES FOR BIOMASS CONVERSION INTO LIQUID FUEL

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The Feedstock

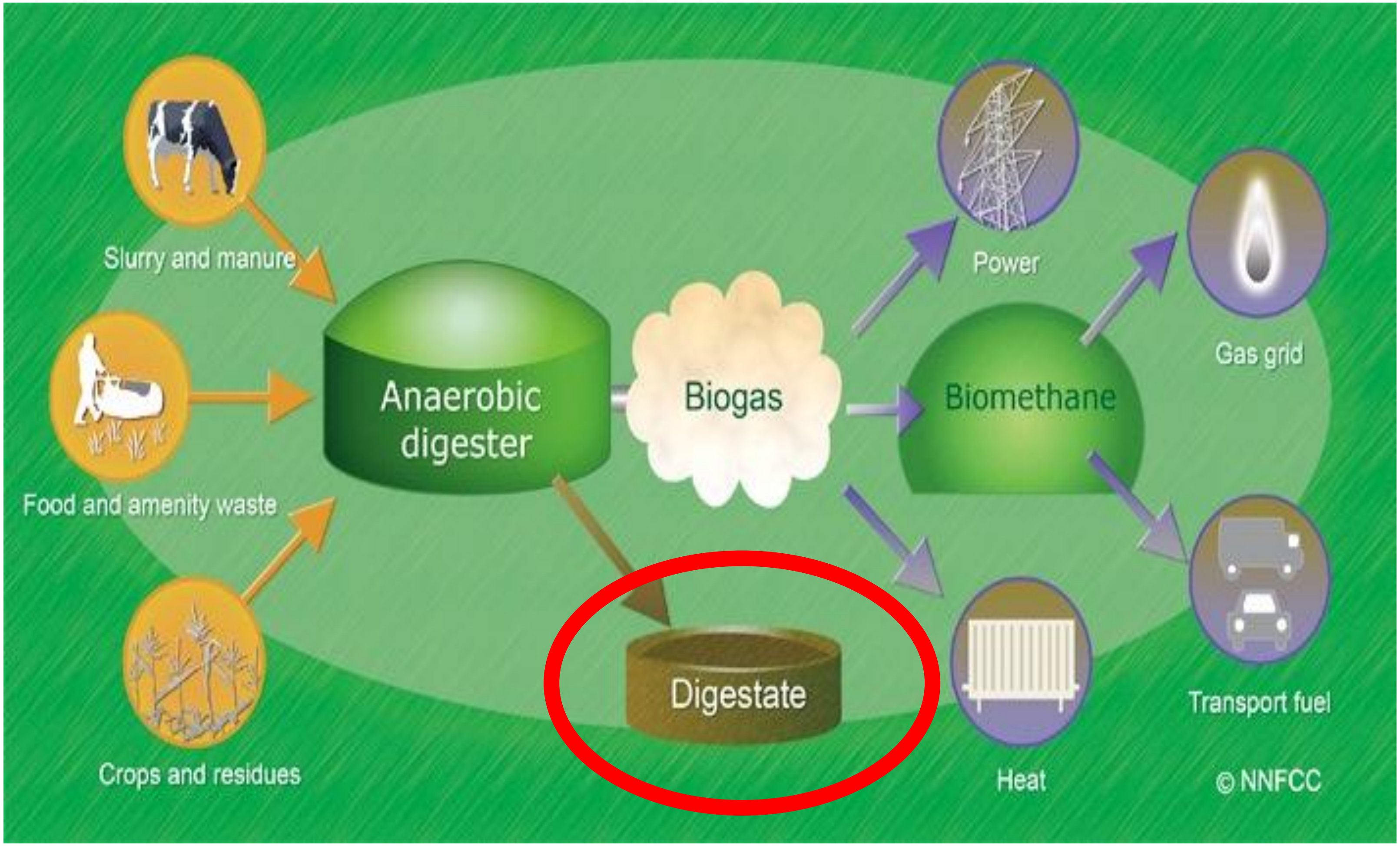
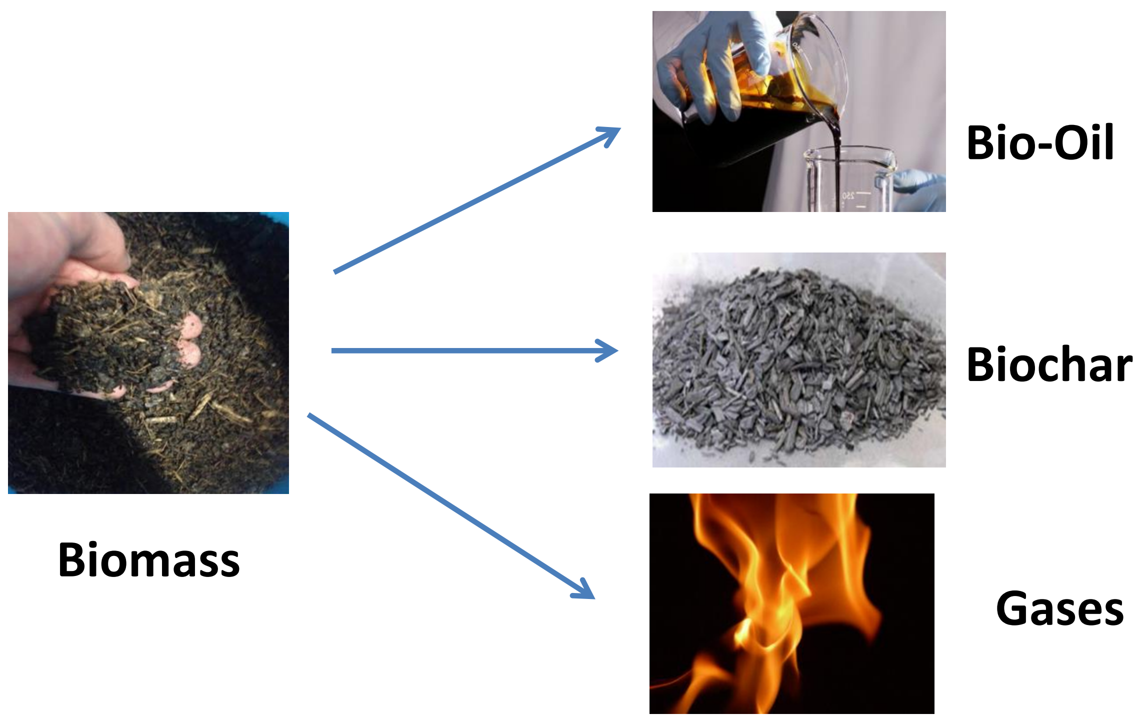


Image from: http://www.hallmarkpower.co.uk/wp-content/gallery/anaerobic/anaerobic-digestion-how_it_works.jpg

Pyrolysis

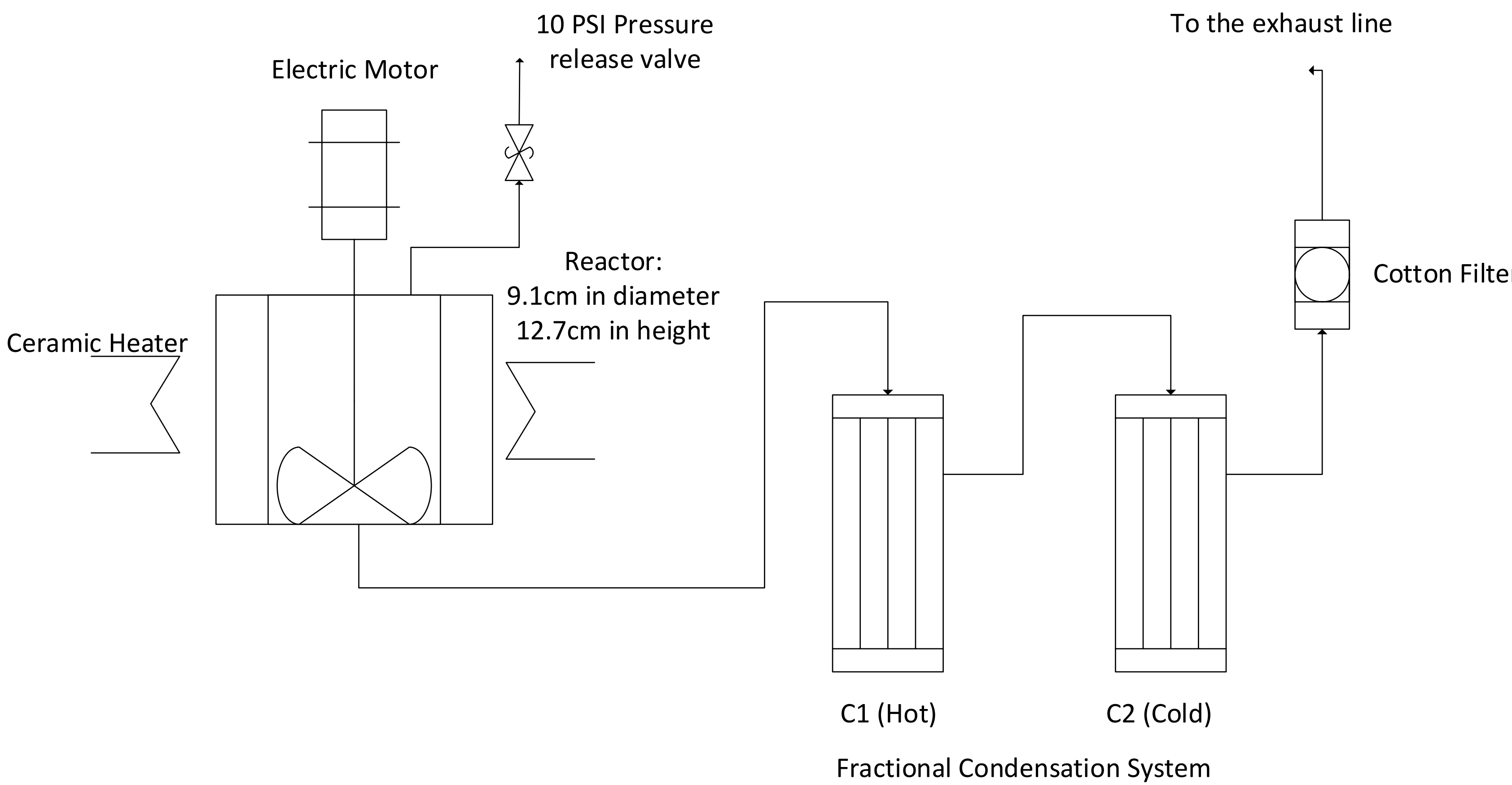
- Ideally suited to feedstocks resistant to further chemical conversion
- Thermochemical decomposition of biomass in the absence of oxygen



Objectives

- Determine best operating conditions for fractional condensation of high-quality bio-oil from anaerobic digestate
- Characterize oil for use as a liquid fuel and chemical feedstock
- Provide an alternative to the disposal of anaerobic digestate

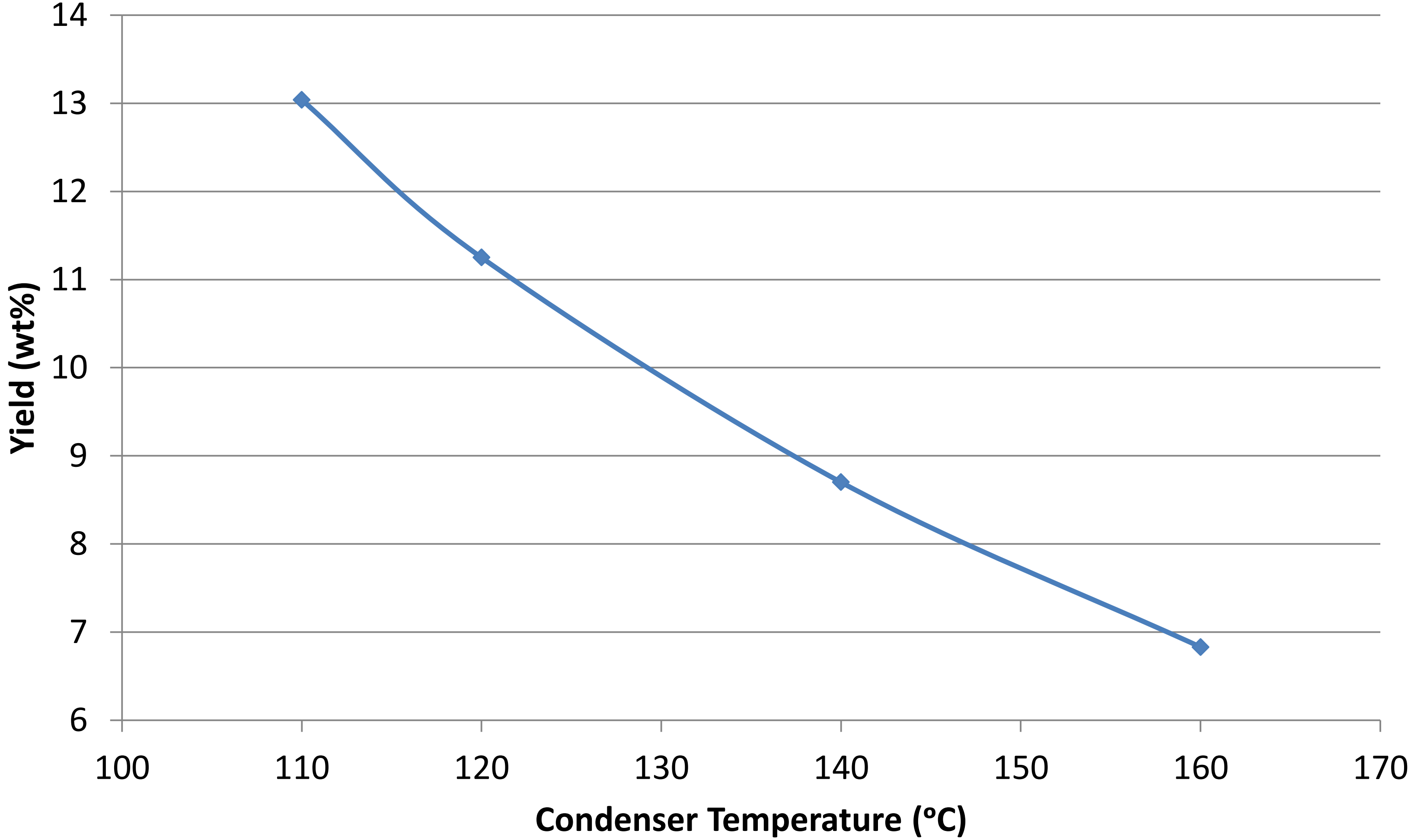
System Setup (Batch MFR)



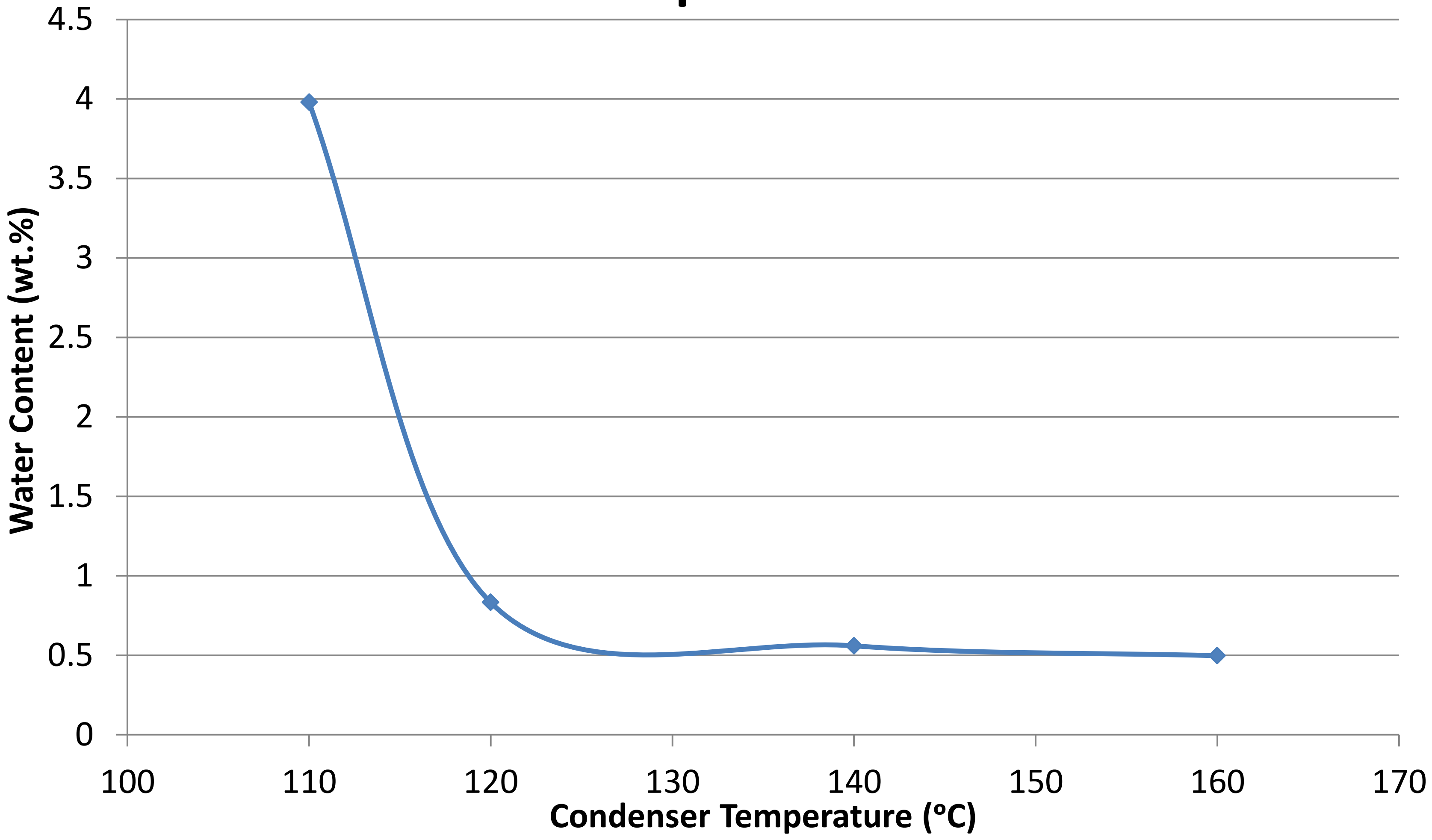
Experimental Methods

- Slow batch pyrolysis
- 80 Grams of biomass
- All runs performed with maximum bed temperature of 550 °C held for 30 minutes
- C1 temperature varied between experiments (110-160 °C)
- C2 kept in an ice bath

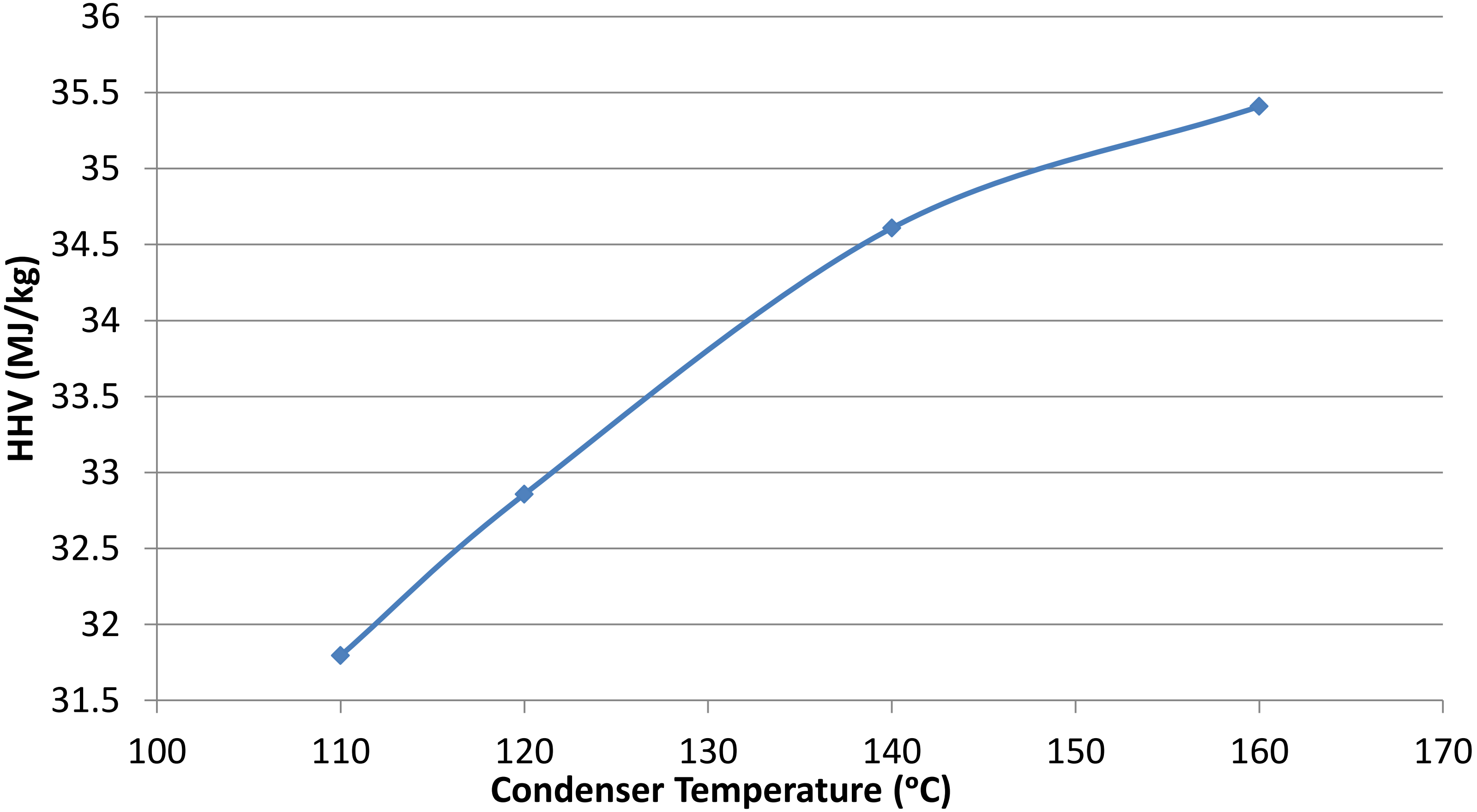
C1 Yield vs C1 Temperature



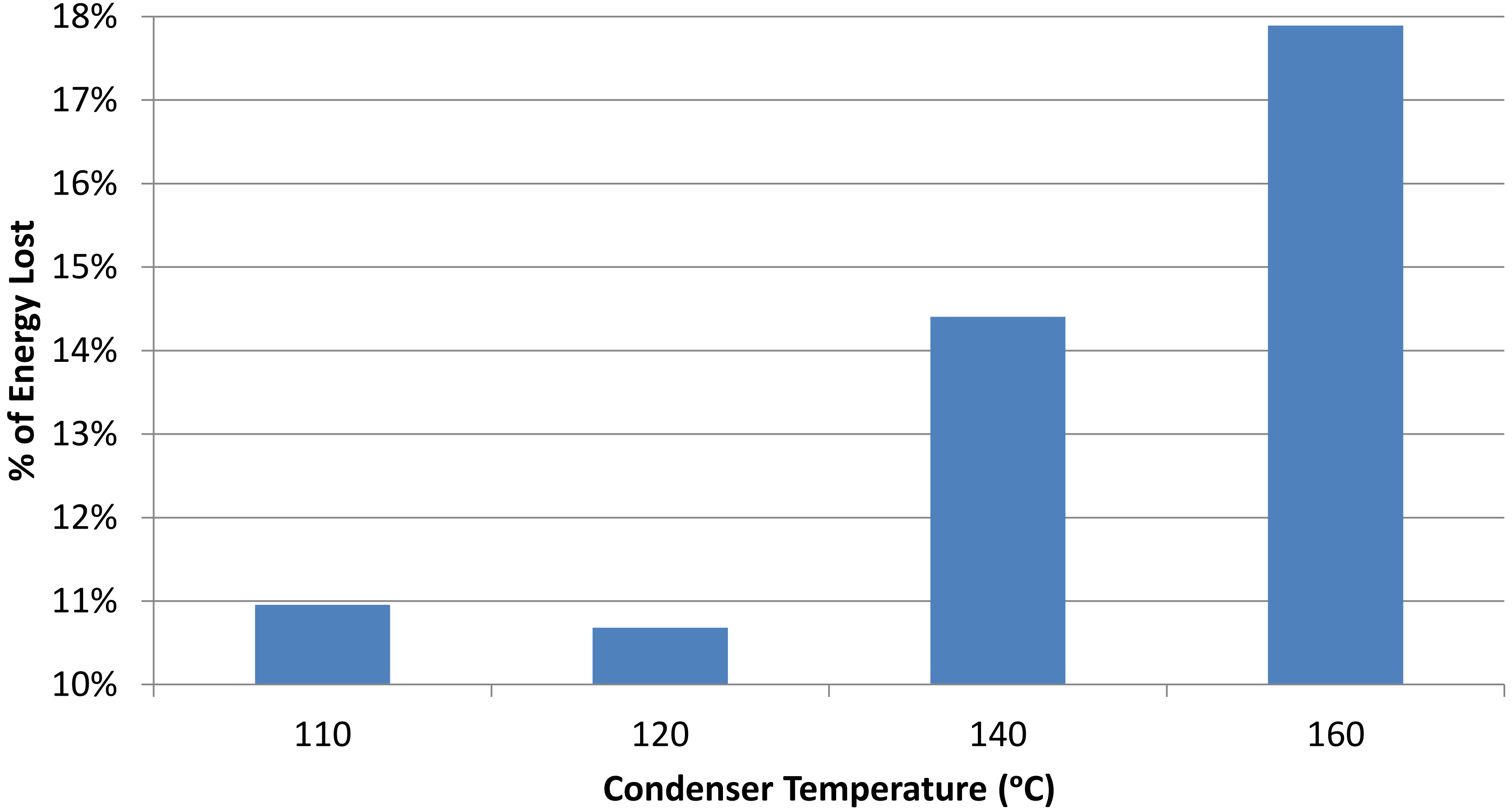
Water Content of C1 Liquid vs C1 Temperature



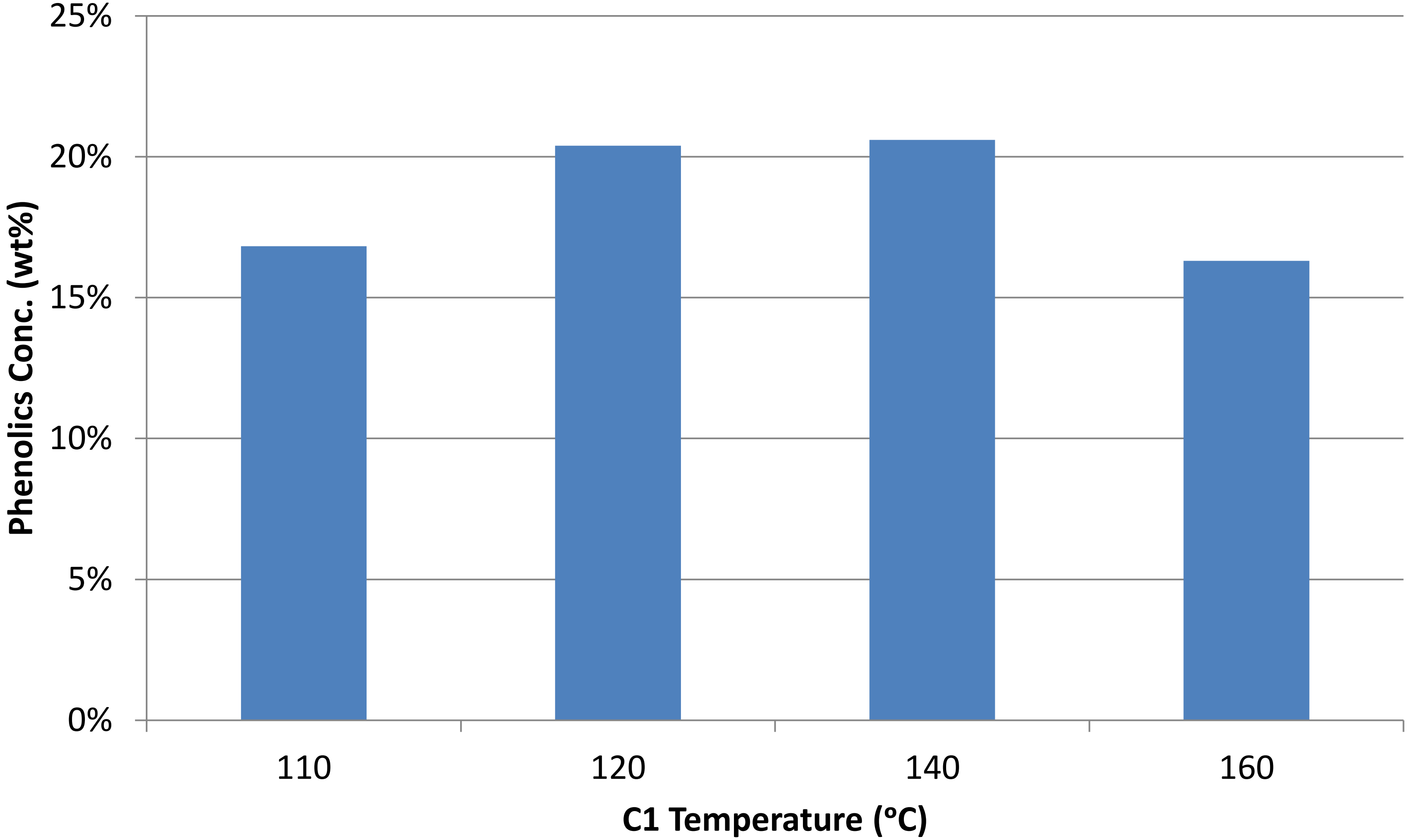
C1 Liquid Heating Value vs C1 Temperature



% Total Energy Lost to C2 Liquid



Phenolics Concentration in C1 Liquid vs C1 Temperature



Summary of Separation Efficiency at Optimum C1 Temperature (120°C)

Measurement	Value
C1 Liquid Water Content	<1%
C2 Liquid Water Content	67%
Total Energy Recovered in C1	89%

- Separation efficiency comparable to other optimization studies
- Separation was not improved by creating agitation in condensers

Comparison of Optimum C1 Liquid vs. Whole Bio-Oil

Measurement	C1 Liquid (120°C)	Whole Bio-Oil
Yield	11.25 %	42%
Water Content	0.8 %	48%
Heating Value	32.8 MJ/kg	11 MJ/kg
Total Energy Recovery	89%	100%
Phenolics Concentration	20 %	11%

- Fractional condensation greatly improves bio-oil quality with only a small loss in energy

Conclusions

- The optimum condenser temperature was found to be 120 °C due to its high energy content and total energy recovery, low water content, and its potential as a phenolic feedstock
- Condenser mixing and heat transfer is very good: enhancement by pulsations did not improve the results.
- This process adds value to what is normally considered a waste stream

Next Steps

- Run experiments with different bed temperatures to determine effect on bio-oi yield and quality
- Scale up process, using jumbo MFR, with optimal process conditions

Questions?