Pilot Scale Continuous Pyrolysis of Pinus Radiata Sawdust

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Outline

- Project background
- Pyrolysis overview
- Feedstock characterisation
- Pilot plant trials
  - Effects of variables on process-ability
  - Effects of variables on product yields
- Process economics
- Conclusions
- Future research

Project background

- Prospective client approached Lakeland Steel Limited for mobile pyrolysis plant feasibility assessment

Technical Trials

- Lab-scale
- Lakeland steel pilot plant
- Effects of pre-drying feedstock, variation of feed rate and reactor temperature.

Economic Feasibility

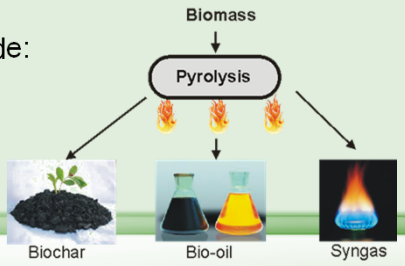
- Identify major variables affecting feasibility

Pyrolysis overview

Pyrolysis is the decomposition of carbonaceous matter under heat in the absence of oxygen.

Key parameters of this process include:

- Feedstock type
- Reaction temperature
- Residence time
- Heating rate



The yields of these products can be tweaked depending on the key parameters

Feedstock characterisation

- Proximate & ultimate analyses
- Drying characterisation
- Thermogravimetric Analysis (TGA)

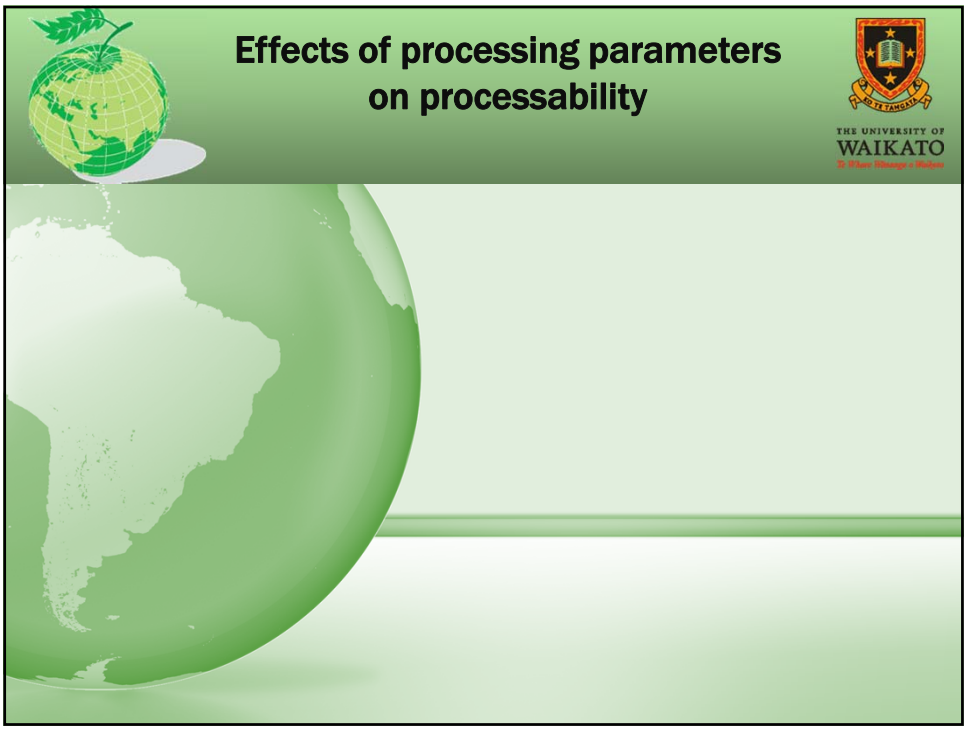
These were used to justify temperatures used in pilot trials and large scale design.

Pilot plant trials

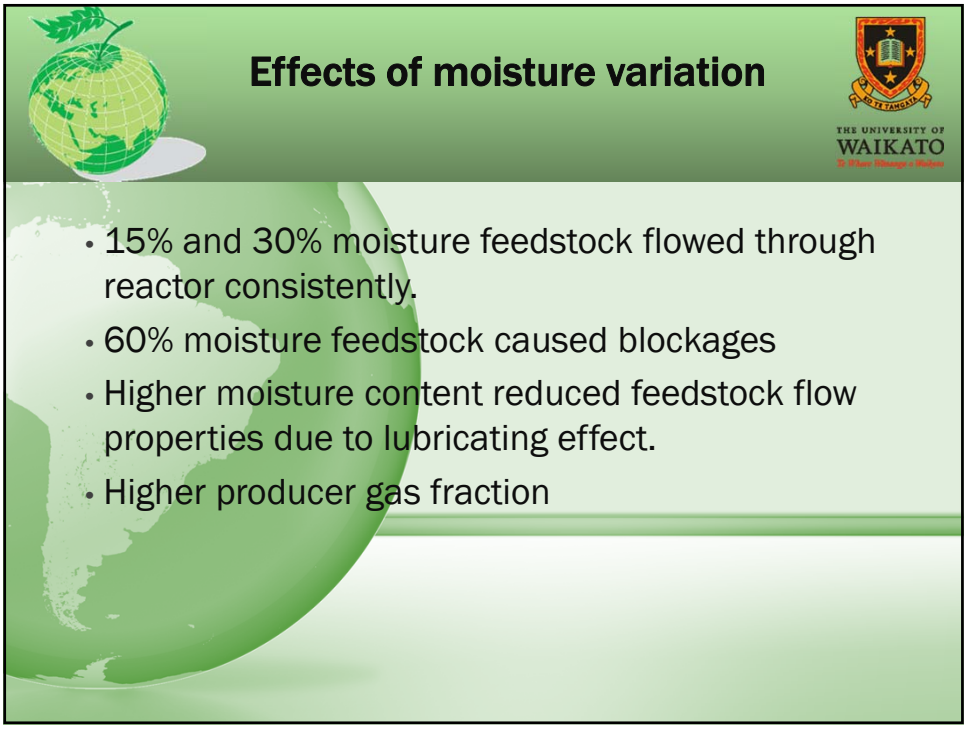
Level	Moisture (%)	Temperature (°C)	Throughput (hertz)
0	15%	400	15
1	30%	450	20
2	60%	500	25

		Factor A		
Factor B	**Factor C**	0	1	2
0	0	000	100	200
0	1	001	101	201
0	2	002	102	202
1	0	010	110	210
1	1	011	111	211
1	2	012	112	212
2	0	020	120	220
2	1	021	121	221
2	2	022	122	222

Effects of processing parameters on processability



Effects of moisture variation



- 15% and 30% moisture feedstock flowed through reactor consistently.
- 60% moisture feedstock caused blockages
- Higher moisture content reduced feedstock flow properties due to lubricating effect.
- Higher producer gas fraction

Effects of temperature variation

- Increase in flame height suggesting higher volume flow rate. Confirmed by rotameter readings
- More tar formed at 400°C
- More oil at 450°C
- More Syngas at 500°C

Effects of reactor auger speed

- Increased speed produced less cooked char
- Higher char volume
- However, increasing speed to values of 30-50 after reactor is operating at steady state increases the rate of gas evolution

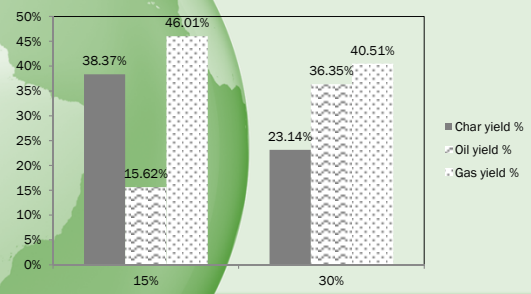
Blockages

Loose sawdust being fed through bulk density 280 kg/m^3

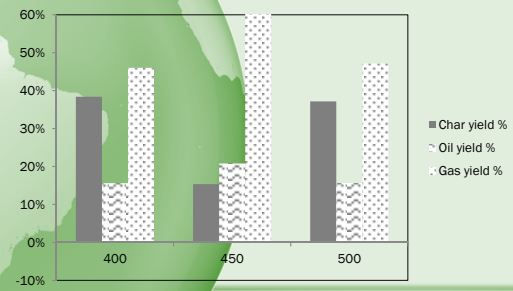
Dry compacted sawdust prior to decomposition, bulk density 1,202 kg/m^3

Effects of process parameters on product yields

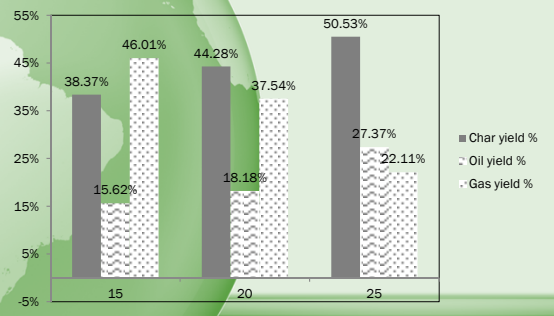
Effects of moisture variation



Effects of temperature variation



Effects of reactor auger speed



Process economics

	Base Case	Optimistic Case
Processing Capacity (Tpa)	29,000	29,000
Capital ($)	736,489	595,783
Operating ($ /ton)	1,207,409	633,989
Revenue ($/ton)	787,215	787,215
Annual Cash flow ($/yr)	(420,194)	153,226
Payback period (yrs)	N/A	3.89

Conclusions

- Increase in moisture content increases tendency of blockages for the temperatures used.
- Process economics are still not favourable however, potential for viability depends on the selling of biochar and development of low cost technology.

•Future research

- Global Model to accurately describe the pyrolytic conversions on a pilot scale.
- Pilot plant run for a significant amount of time to improve operating cost data.

Ministry of Science and Innovation (MSI)

Dr Mark Lay
University of Waikato

Cory Leatherland
General Manager of Lakeland Steel Limited

Other Staff and Students who helped along the way

Pyrolysis product applications

Char	Bio-oil	Syngas
		
• Soil amendment • Low sulfur fuel • Water/air filtering medium once activated • Catalyst support • Traditionally used as antidote • Reducing agent	• Is composed of many hydrocarbons such as acetic acid • Can be upgraded to biodiesel • In some cases can be burned as fuel	• A “cleaner” fuel replacement for LPG or natural gas • Used for electricity generation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