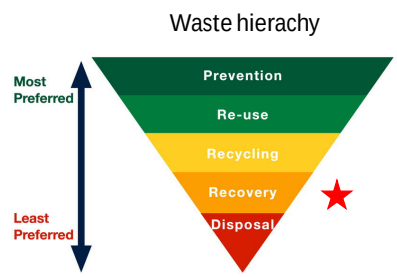
Thermal Processing by Pyrolysis

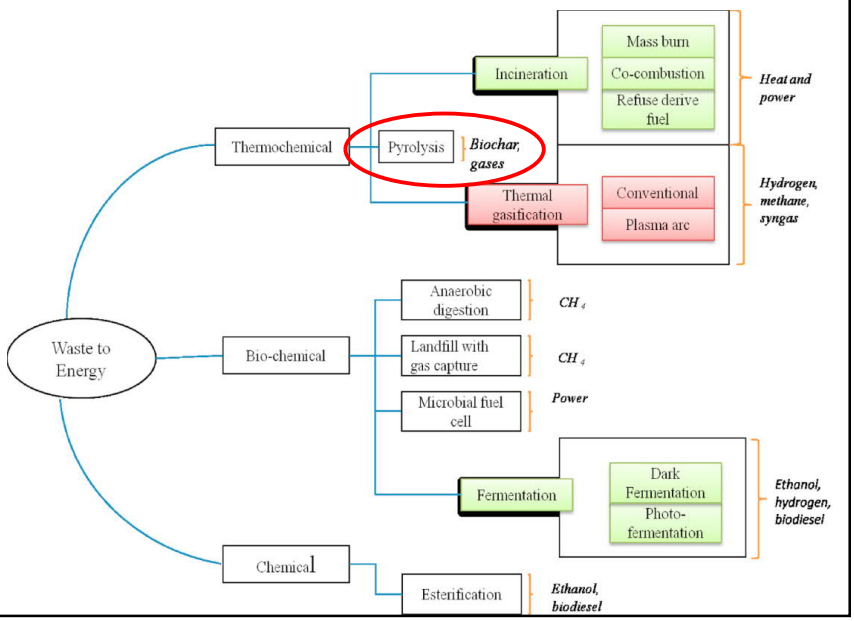
Jim Jones

Professor and Research Lead
School of Food and Advanced Technology

1

Pyrolysis is one of the Waste-to-Energy Technologies





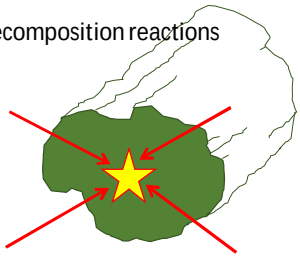
2

Science of Pyrolysis

Pyrolysis is:

the thermal decomposition of carbonaceous materials in the absence of oxygen

Decomposition reactions



Pyrolysis is:

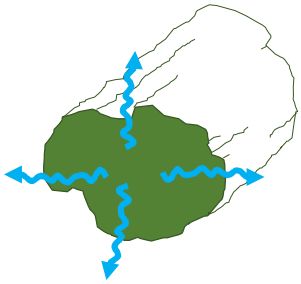
the first step in combustion

3

Science of Pyrolysis

Pyrolysis is:

the thermal decomposition of carbonaceous materials in the absence of oxygen



Mass transfer out

Pyrolysis is:

the first step in combustion

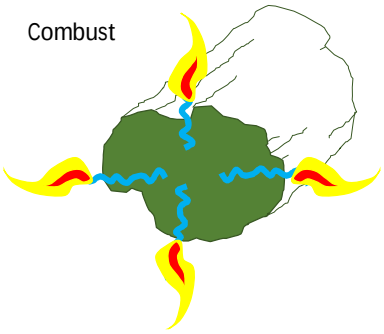
4

Science of Pyrolysis

Pyrolysis is:

the thermal decomposition of carbonaceous materials in the absence of oxygen

Combust



Pyrolysis is:

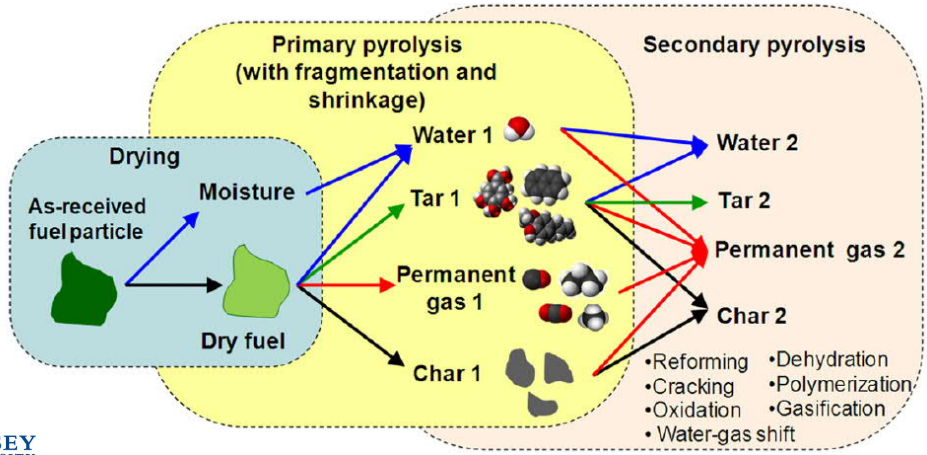
the first step in combustion

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

5

Science of Pyrolysis

Pyrolysis is a series of complex decomposition reactions



MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

6

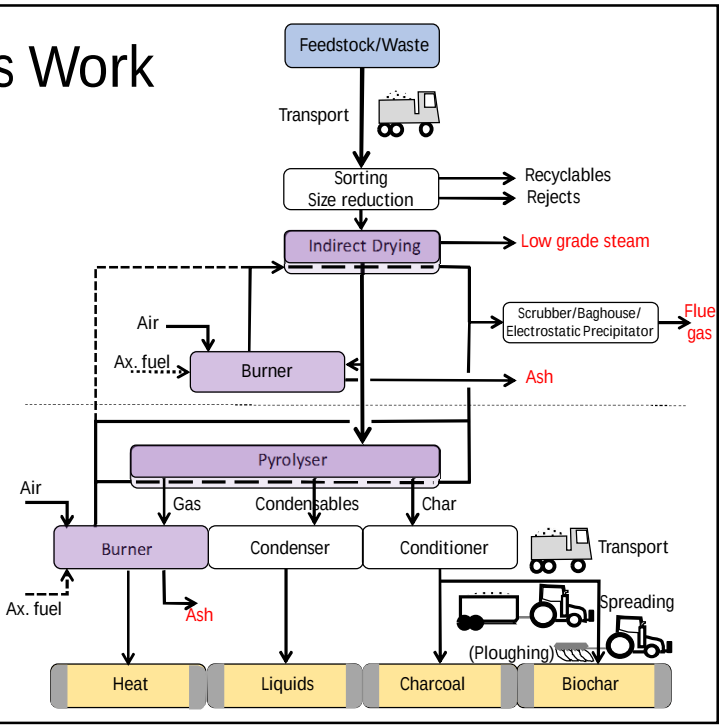
Science of Pyrolysis

Types of pyrolysis

Mode	Conditions	Liquid	Char	Gas
Fast	Moderate temperature ~ 500°C short vapor residence time ~ 1 s	75%	12%	13%
Moderate	moderate temperature ~ 500°C moderate vapor residence time ~ 10-20 s	50%	20%	30%
Slow	moderate temperature ~ 500°C very long vapor residence time ~ 5-30 min	30%	35%	35%
Gasification	high temperature > 750°C moderate vapor residence time ~ 10-20 s	5%	10%	85%

7

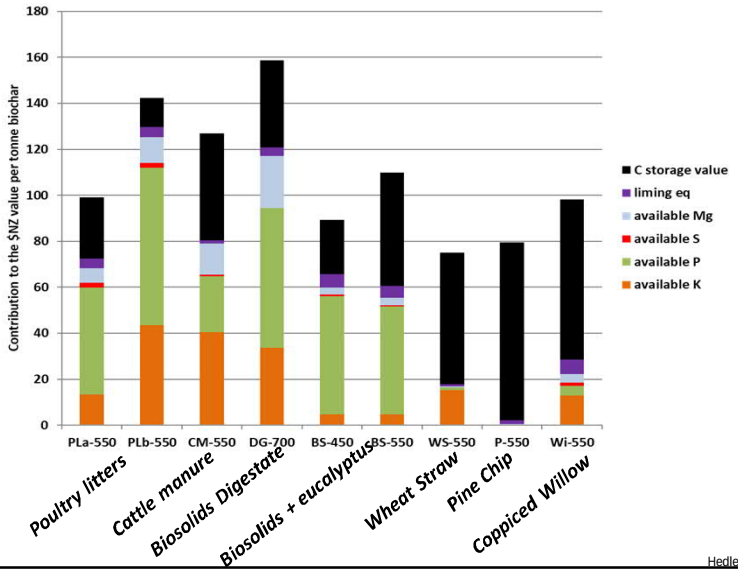
How Pyrolysis Plants Work



8

Does the biochar have fertiliser value?

Values used were 2.55 NZ$ kg^{-1}P, 1.30 NZ$ kg^{-1} K, 0.55 NZ$ kg^{-1}S, 1.30 NZ$ kg^{-1}Mg , and Lime 0.03 NZ$ kg^{-1}Ca CO_3. The carbon storage value is based on a calculated BC_{+100} using IBI protocols and a C price of 35 NZ$ $t^{-1}CO_2$ e



Hedley et al. 2020

9

Feedstocks

Type and typical composition of municipal solid waste.

Category	Common sources
Organic waste	• Kitchen waste (e.g. food waste including fruit and vegetable residues) • Agro-food residues (e.g. solid food processing wastes) • Yard waste (e.g. leaves, grass, tree trimmings and barbeque wood)
Paper	• Scrap paper • Newspaper • Magazines • Books • Paper bags • Wet wipes • Tissue paper and napkins • Parchment paper • Wrapping paper • Cardboard • Packaging boxes
Plastic	• Bottles • Containers, container lids and caps • Boxes • Clear wraps • Ziplock bags • Polyethylene bags • Polystyrene • Cable wire • Pipes • CDs, DVDs and vinyl records
Miscellaneous	• Electronic waste (e.g. thrashed computers, monitors, tablets phones, watches, batteries and other electronic goods) • Broken appliances • Textiles • Leather • Rubber • Pet litter • Personal hygiene products • Health care products • Pharmaceuticals • Cosmetics • Discarded furniture

10

Thermal Processing by Pyrolysis

Jim Jones

Professor and Research Lead
School of Food and Advanced Technology

11