Flash Pyrolysis of Waste Tires

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Enschede, February 14th 2024

UNIVERSITY OF TWENTE.

In this presentation:

- Introduction of tires and their waste streams
- Waste tire management
- Thermal conversion processes
- Fast pyrolysis of waste tires
- Recent research results
- Concluding remarks

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Tires graveyard

- ELT waste is 2% of total solid waste world-wide
- More than 1 billion waste tires world-wide per year

Waste tires management

- Waste tires to landfills in the EU: 50% in 1996, illegal now
- Global average still 75% to landfills
- Recycling of waste tires:
  - 54% for material recovery (granulation in cement, civil applications)
  - 50% for energy recovery (cement kilns, power plants)

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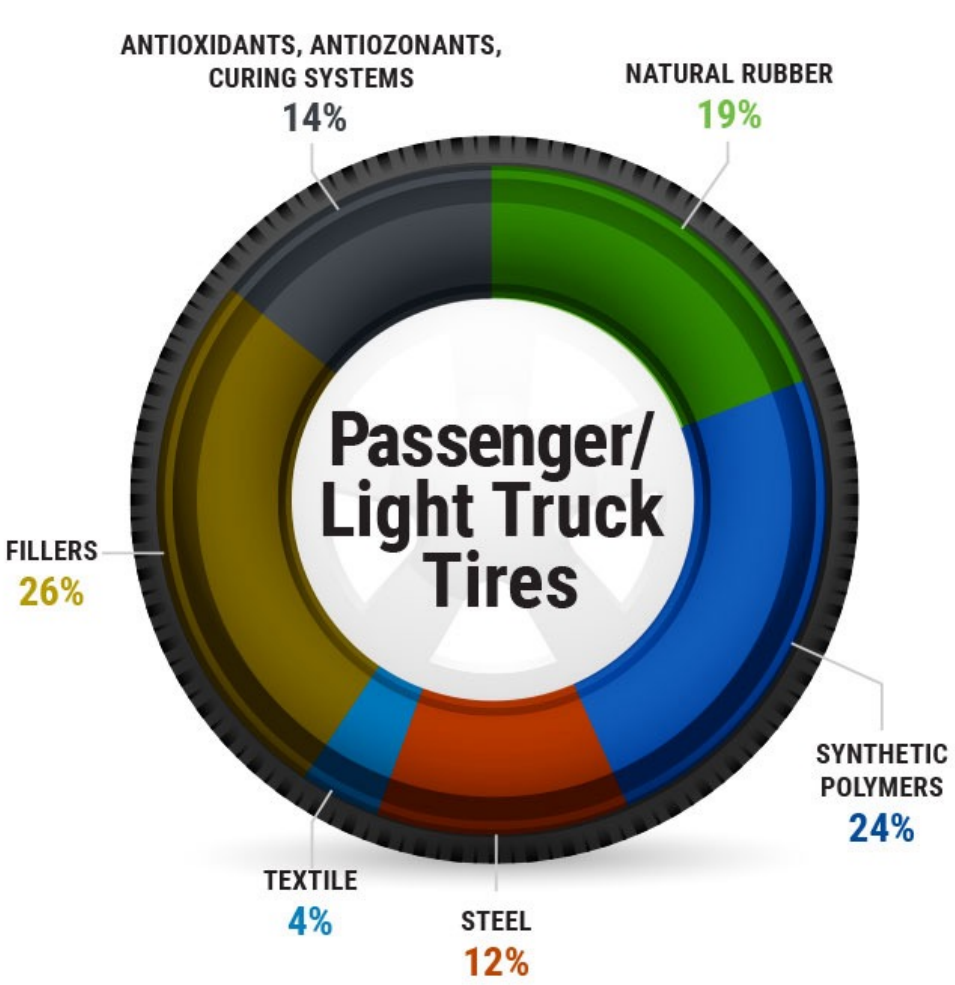
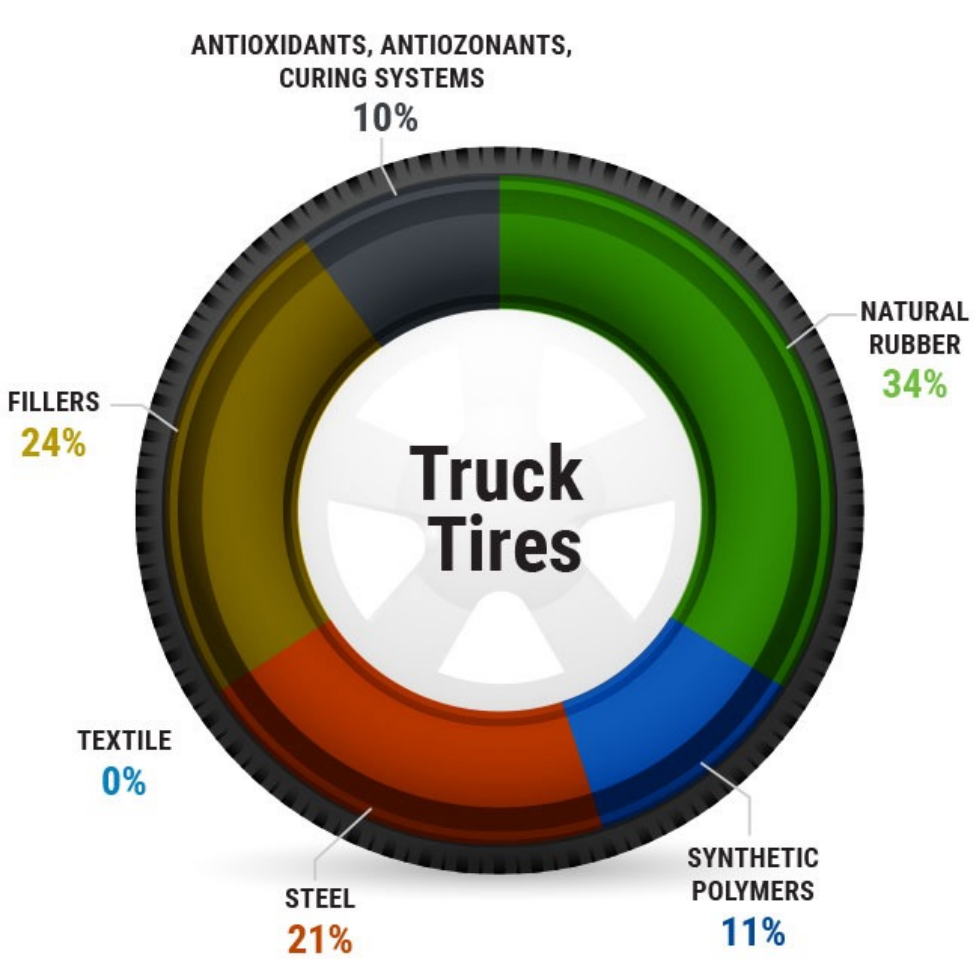
Car tires





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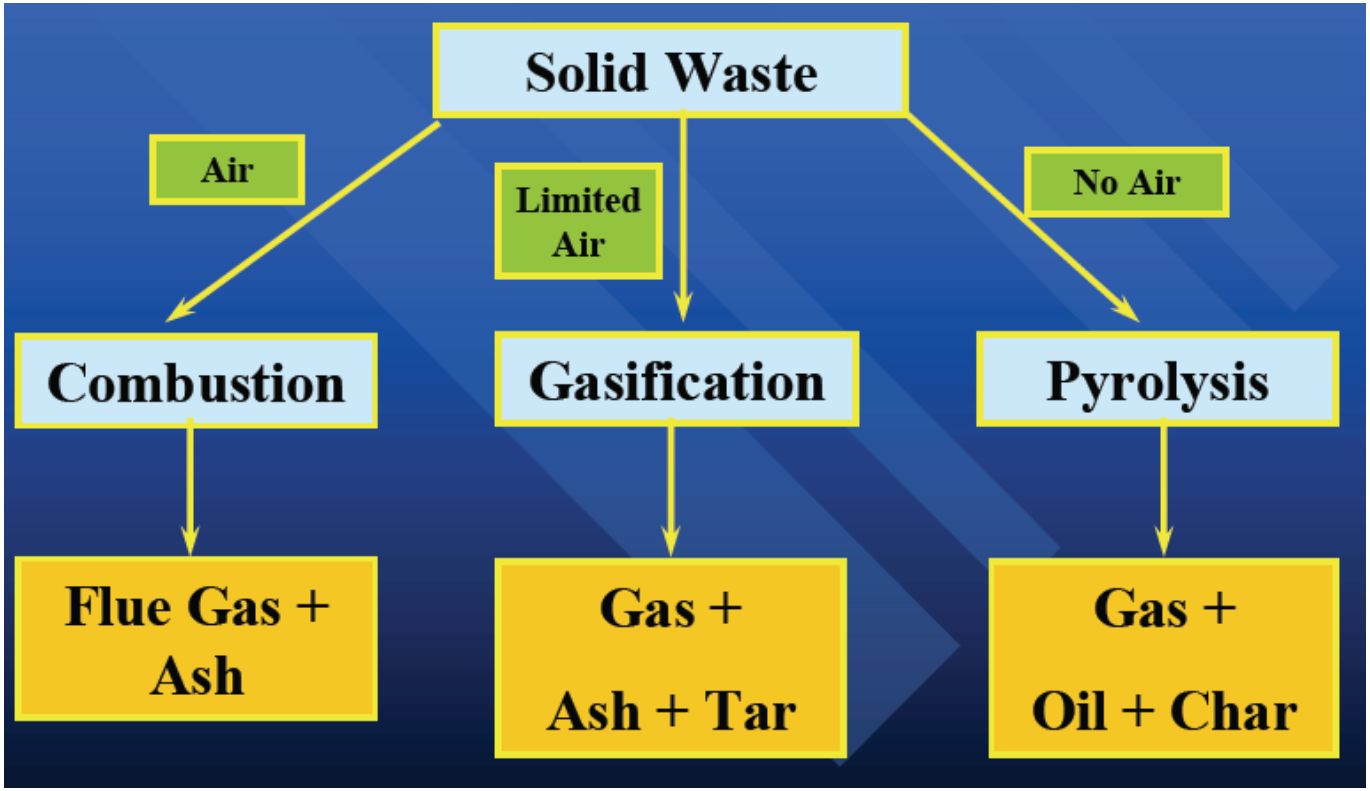
Sustainability

- Sustainable waste management (reuse of materials)
- Substitute for depleting raw materials (reduced fossil fuels)
- CO_2 emission control (CO_2 footprint)

Thermal conversion processes



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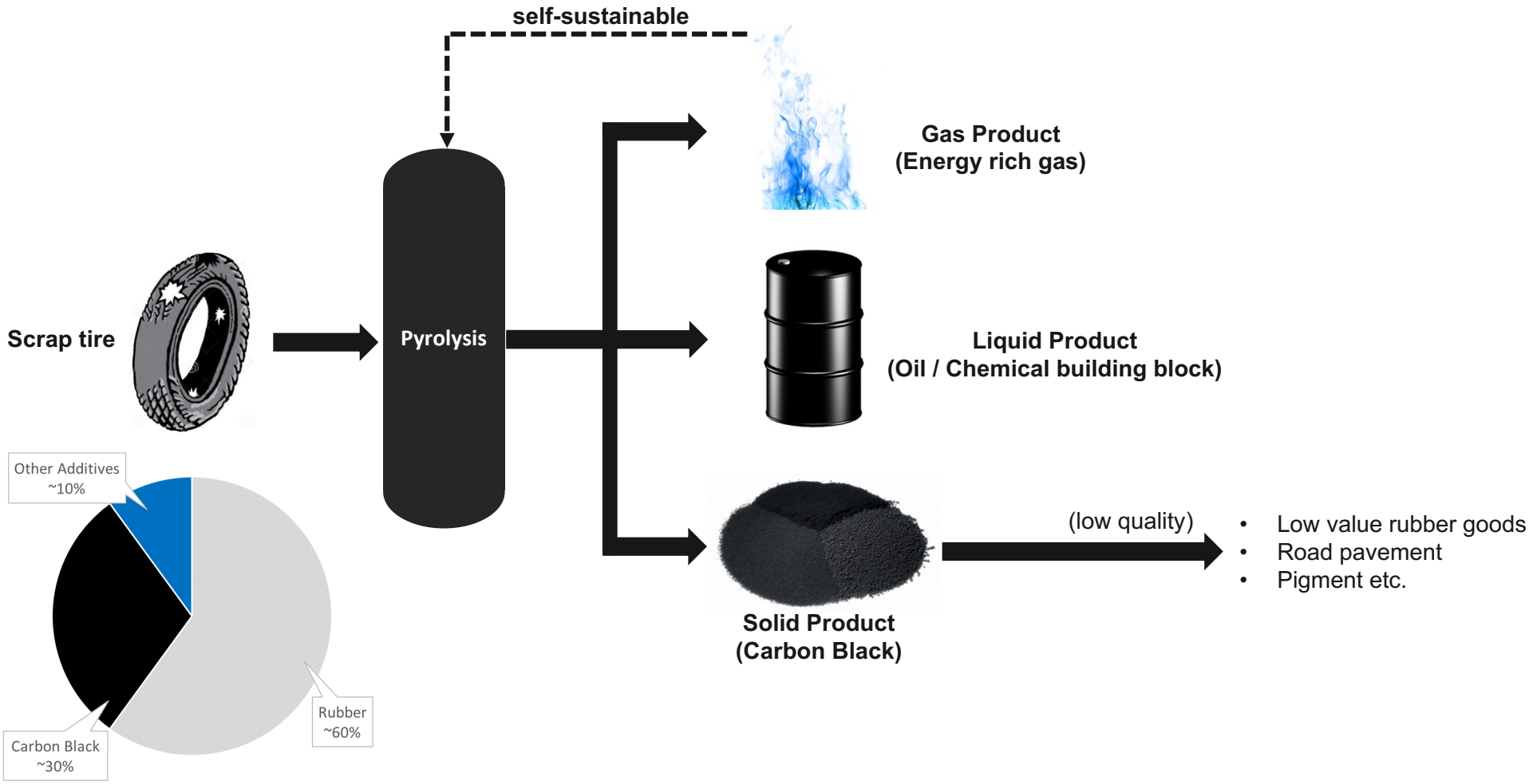
Pyrolysis Process

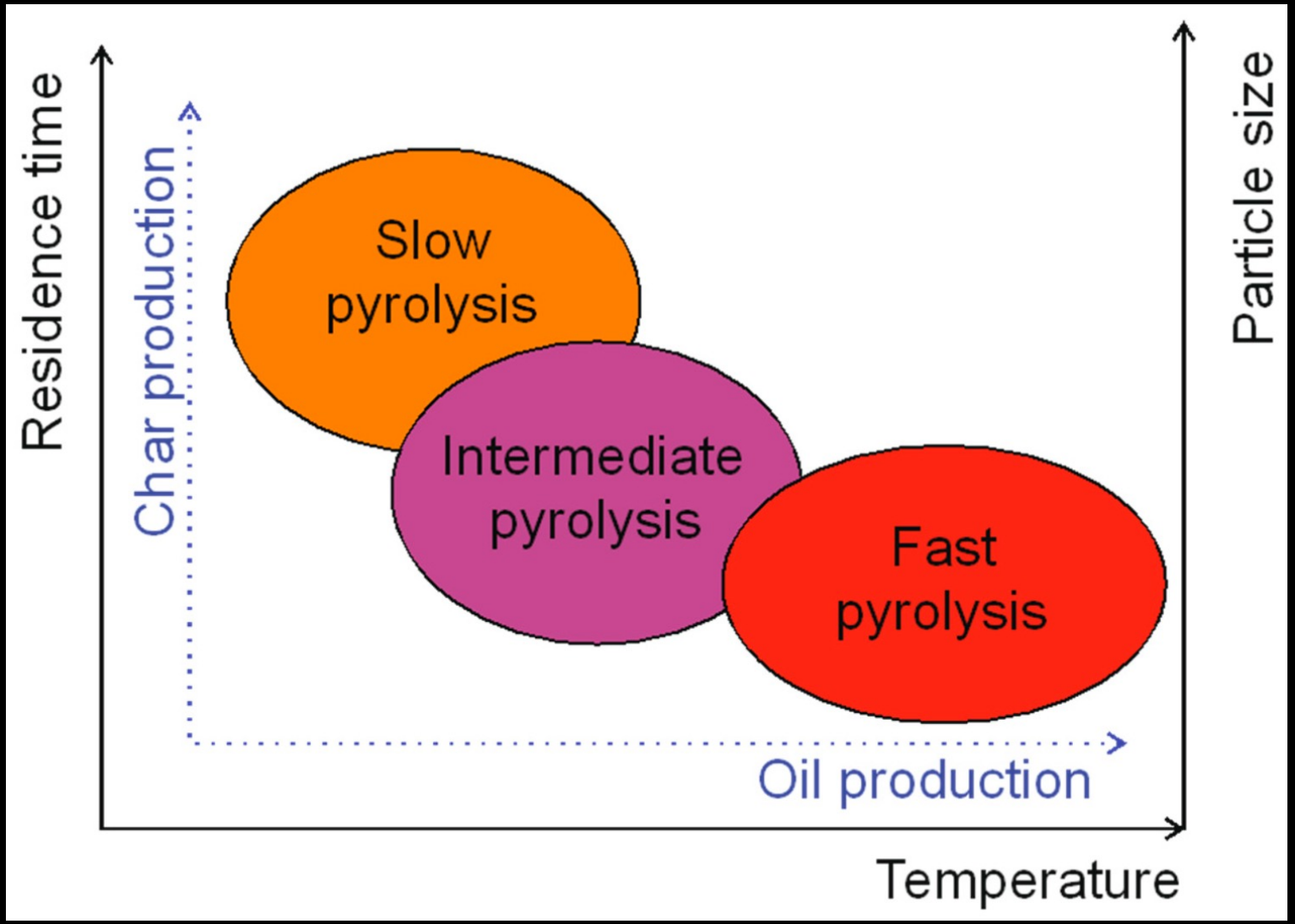


Pyrolysis process – key parameters

Product yields and characteristics obtained from waste tires depend on:

- Type and size of feedstock
- Temperature
- Size and system configuration of reactor
- Efficiency of heat transfer
- Residence time

Slow vs Fast Pyrolysis



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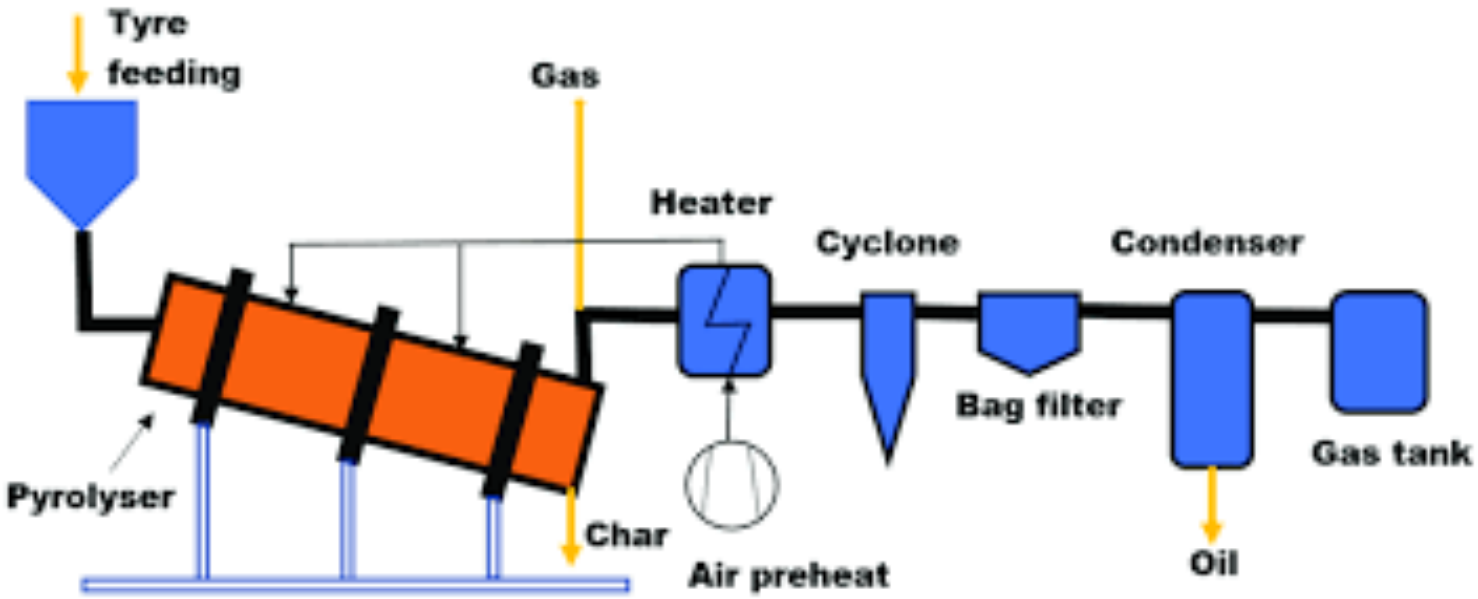
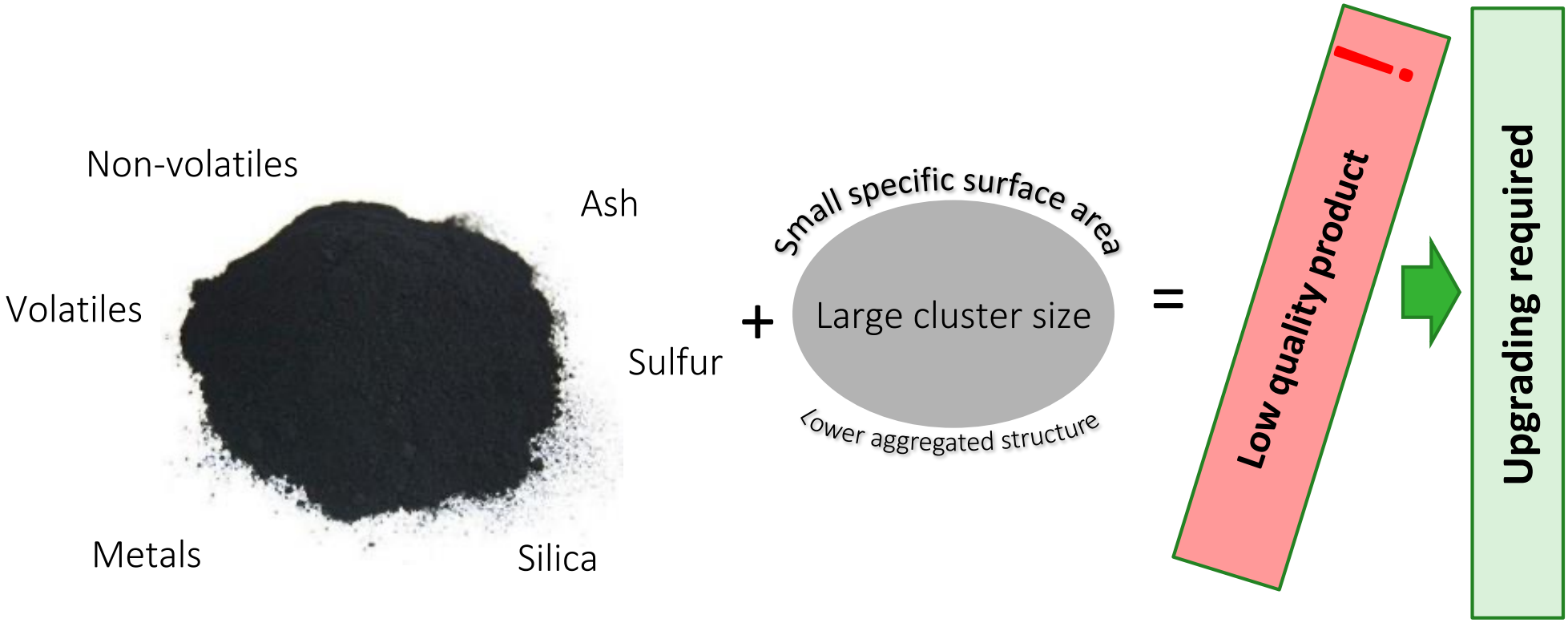
Slow pyrolysis rotary kilns



- Long residence time
- Large reactors
- Poor temperature control
- Low-grade product quality
- Standard technology for companies

Conventional pyrolytic carbon black



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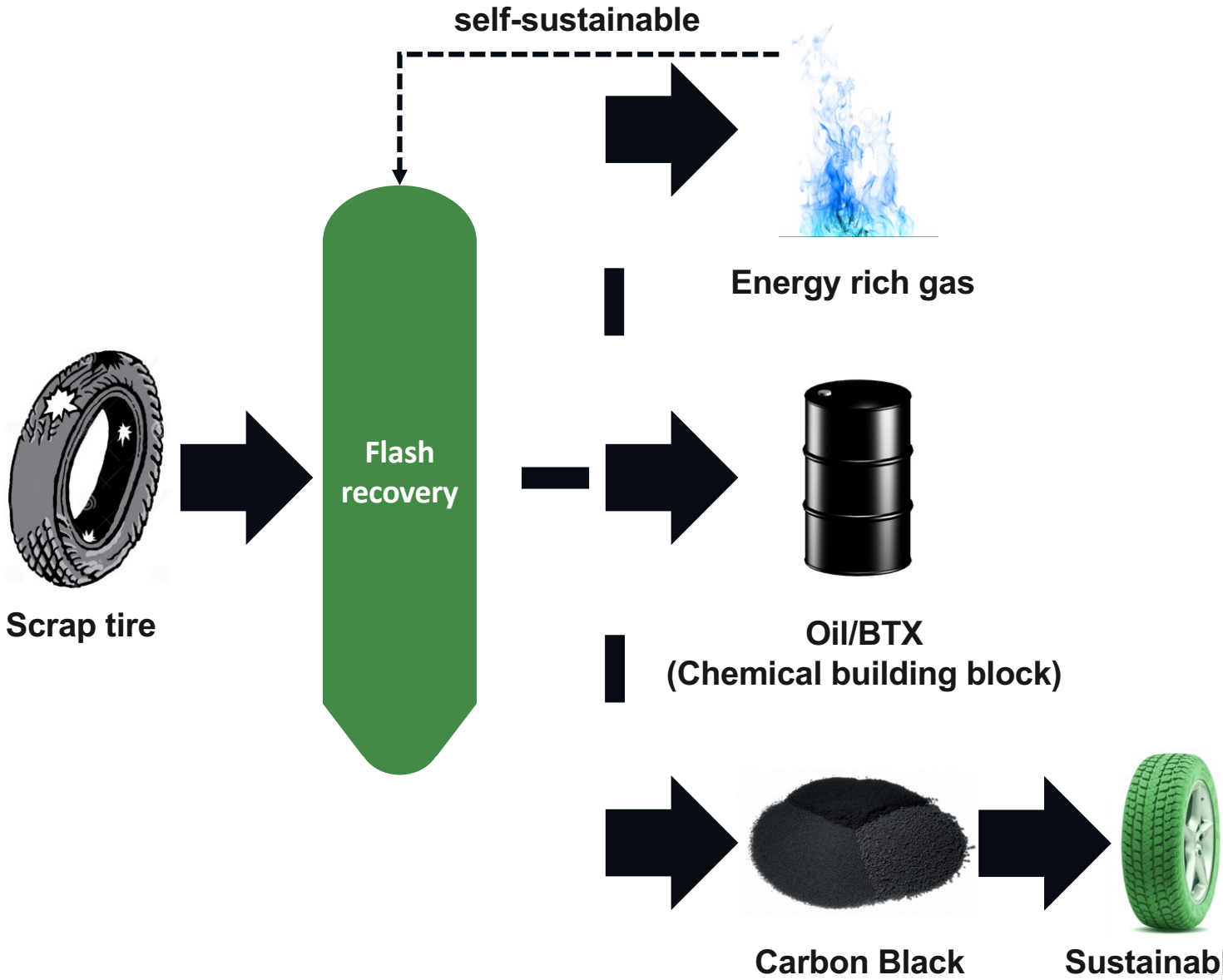
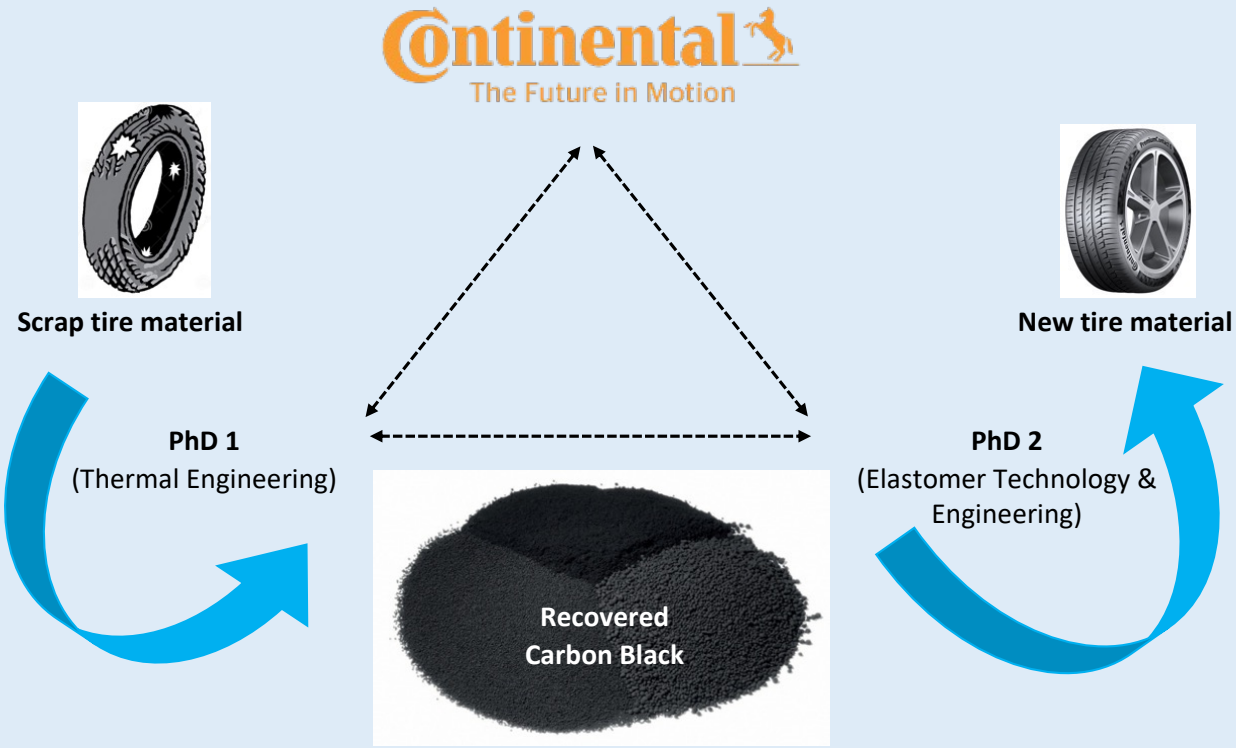
Process Schematic (Flash recovery)



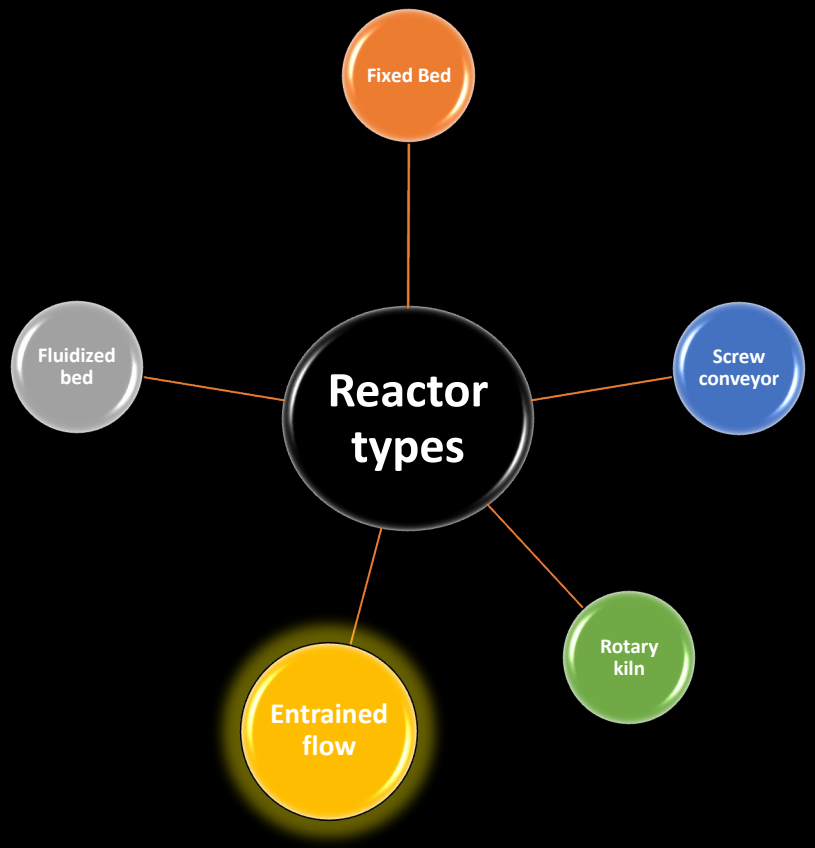
Cradle-to-Cradle loop

Research consortium

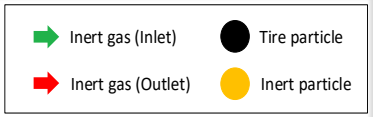


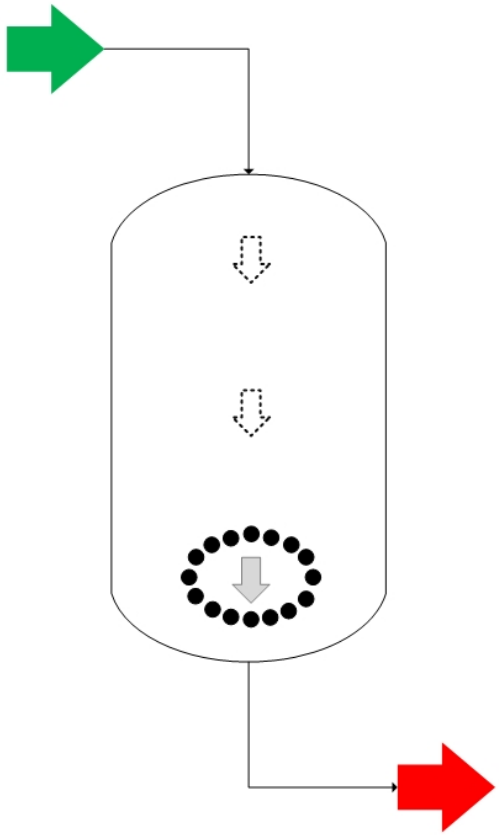
Sponsored by M2i

Reactors



Entrained flow





+ short residence time
+ uniform temperature profile
+ continuous operation
+ scalable

- particle size limit

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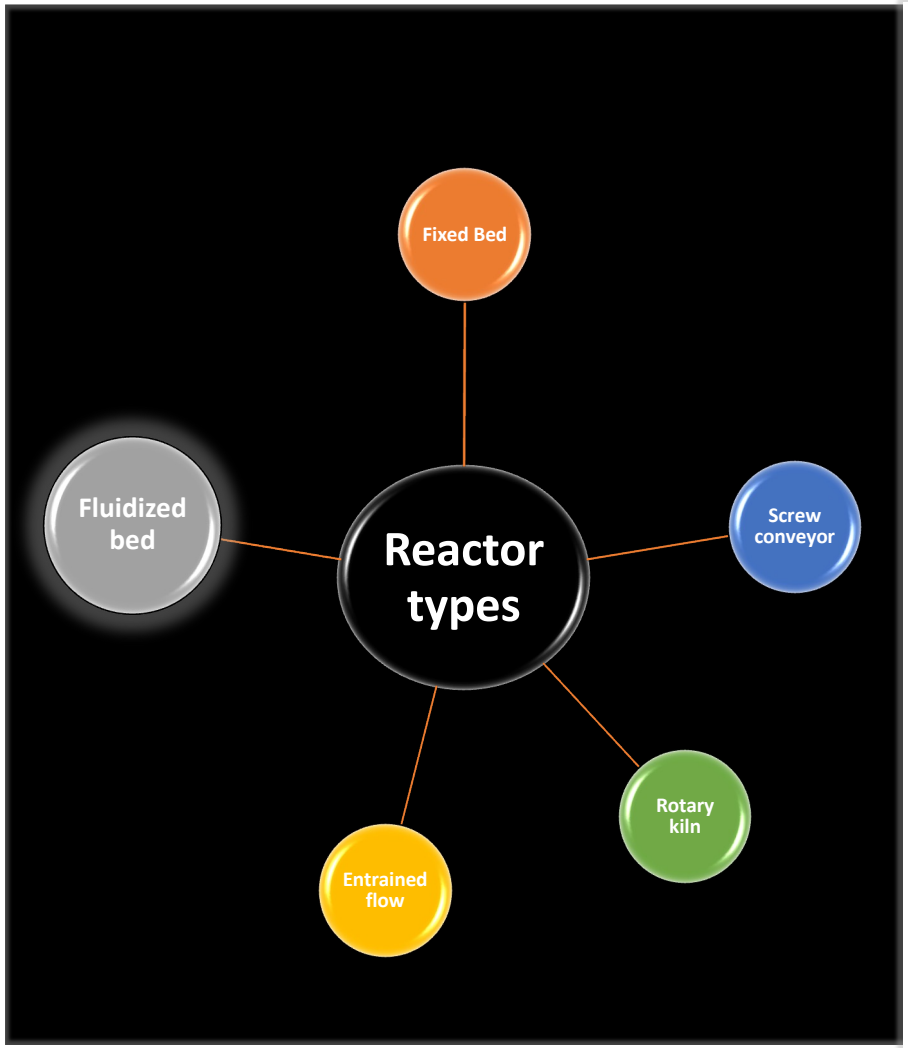
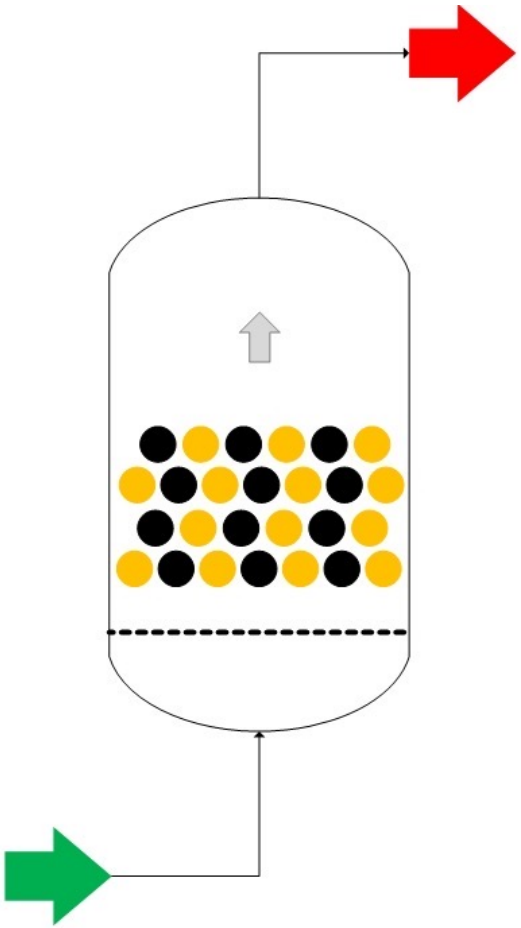
Reactors



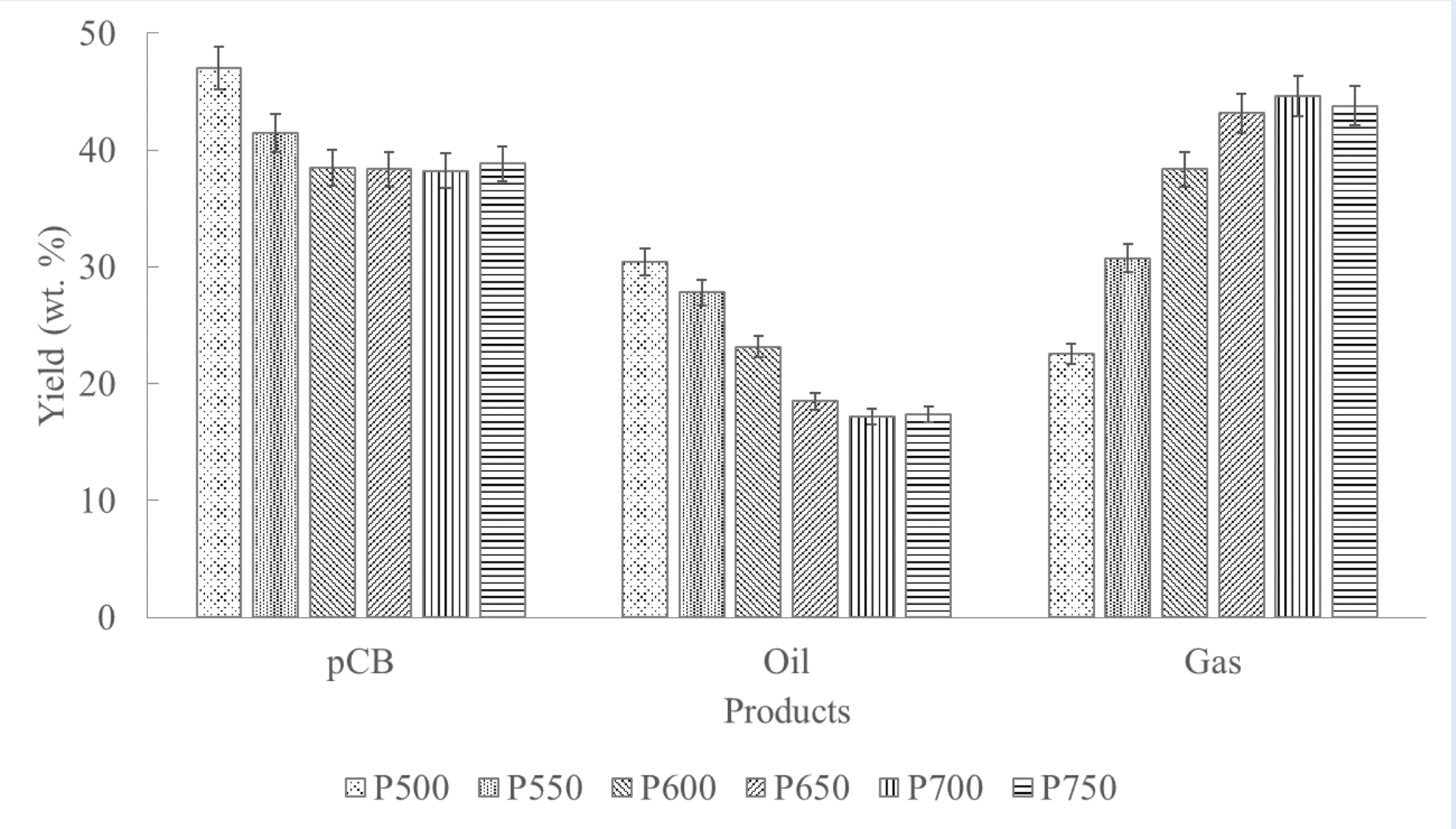
Fluidized bed



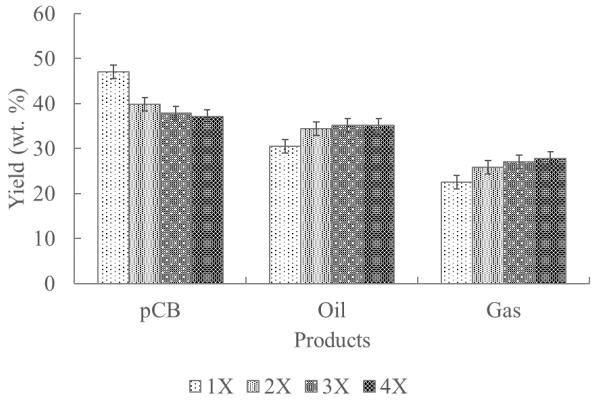
+ high heat transfer rate
+ uniform particle mixing
+ uniform temperature profile
+ continuous operation
+ scalable

- pressure drop
- particle entrainment

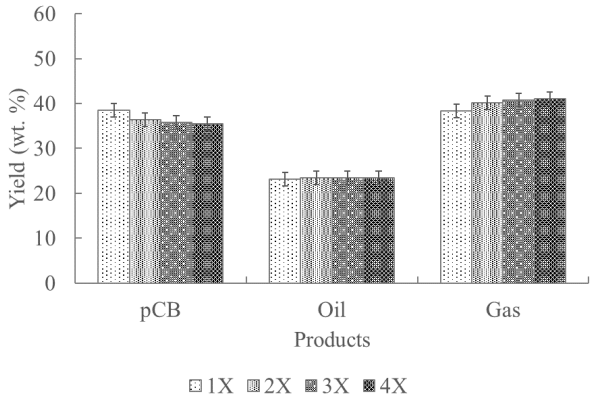
Temperature study



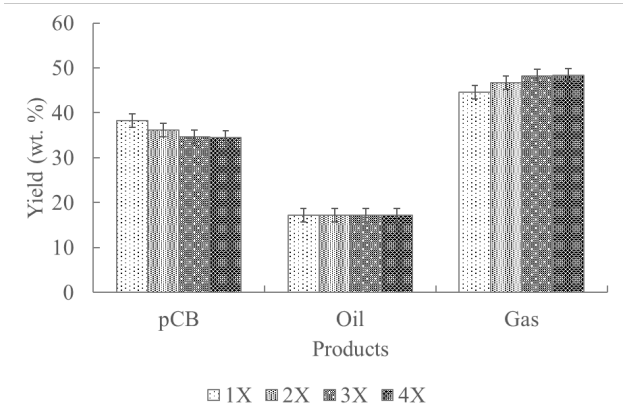
Residence time study



Product yields at 500°C

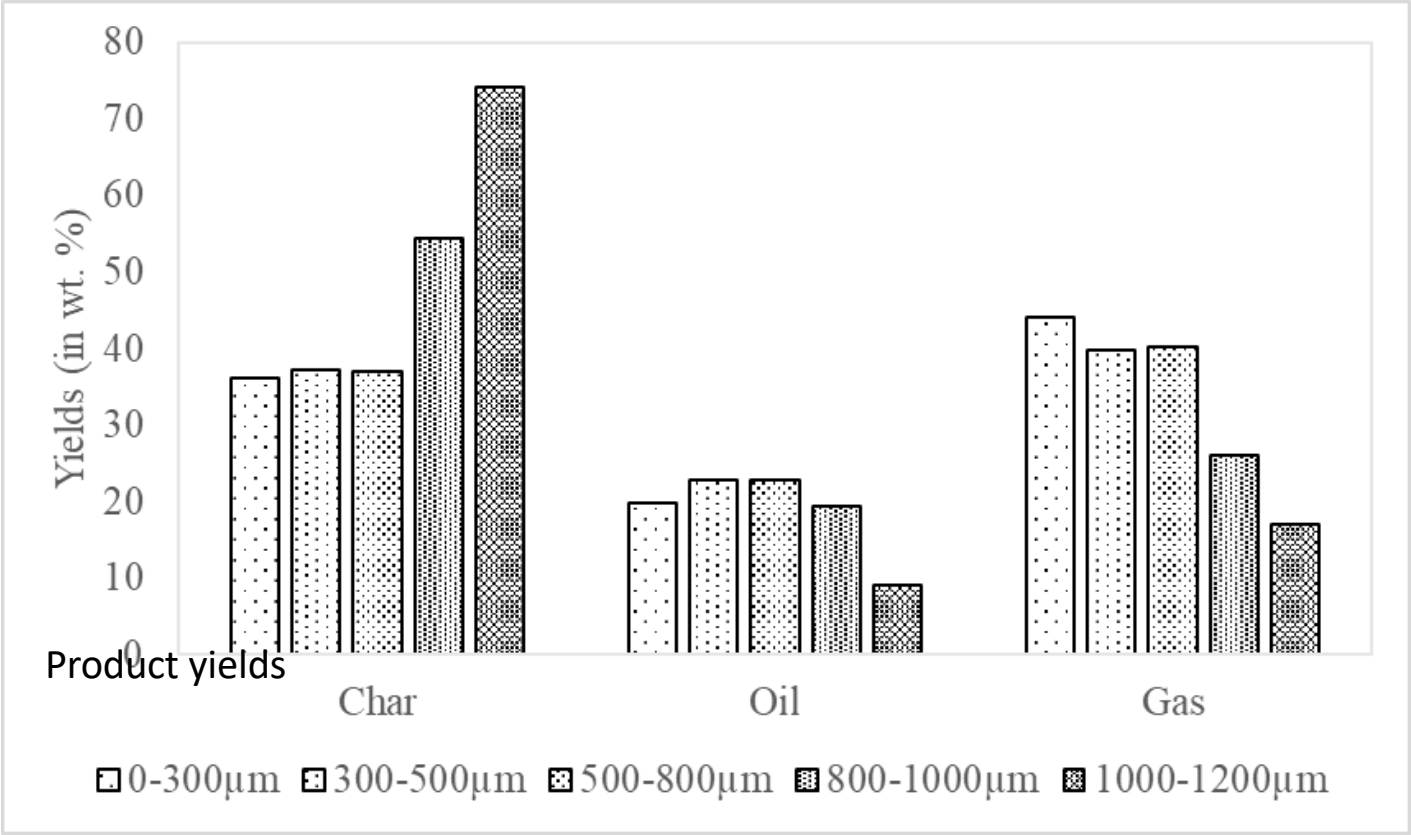


Product yields at 600°C



Product yields at 700°C

Particle size study

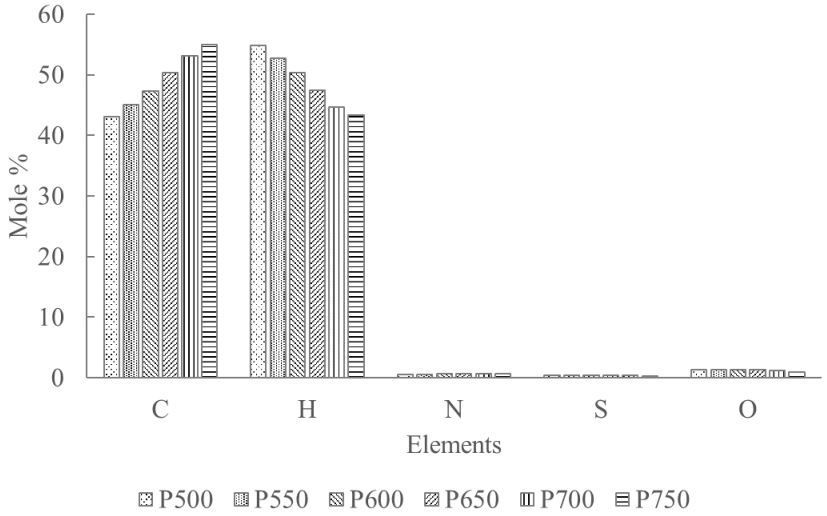


Product yields

Conclusions from Process Study in Downer

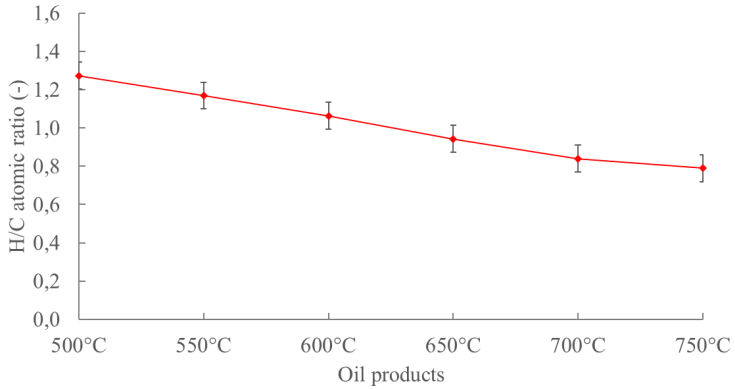
- Process is stable and reproducible
- Temperature: above 600°C, there is no significant improvement in pCB quality
- Temperature: above 700C, less oil production/more gas
- Residence time: 2x and >600°C, pCB quality is comparable with N660
- Particle size: required conversion time increases significantly for feed particles above 0,8mm
- Feed material: no significant difference in produced pCB quality from PCT and TCT

Pyrolysis Oil Properties

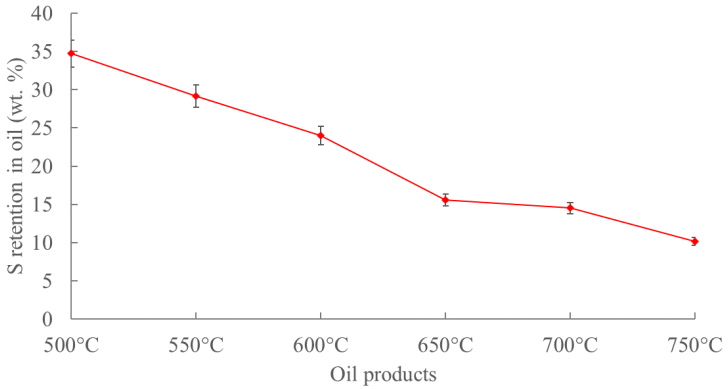


Molar composition

- Yield = 17-30 wt. %
- H/C ≈ 1 (aromatic!!)
- S content = 1-2 wt.%
  [0.0015 wt.% in transportation fuel]
- HHV = 39-42

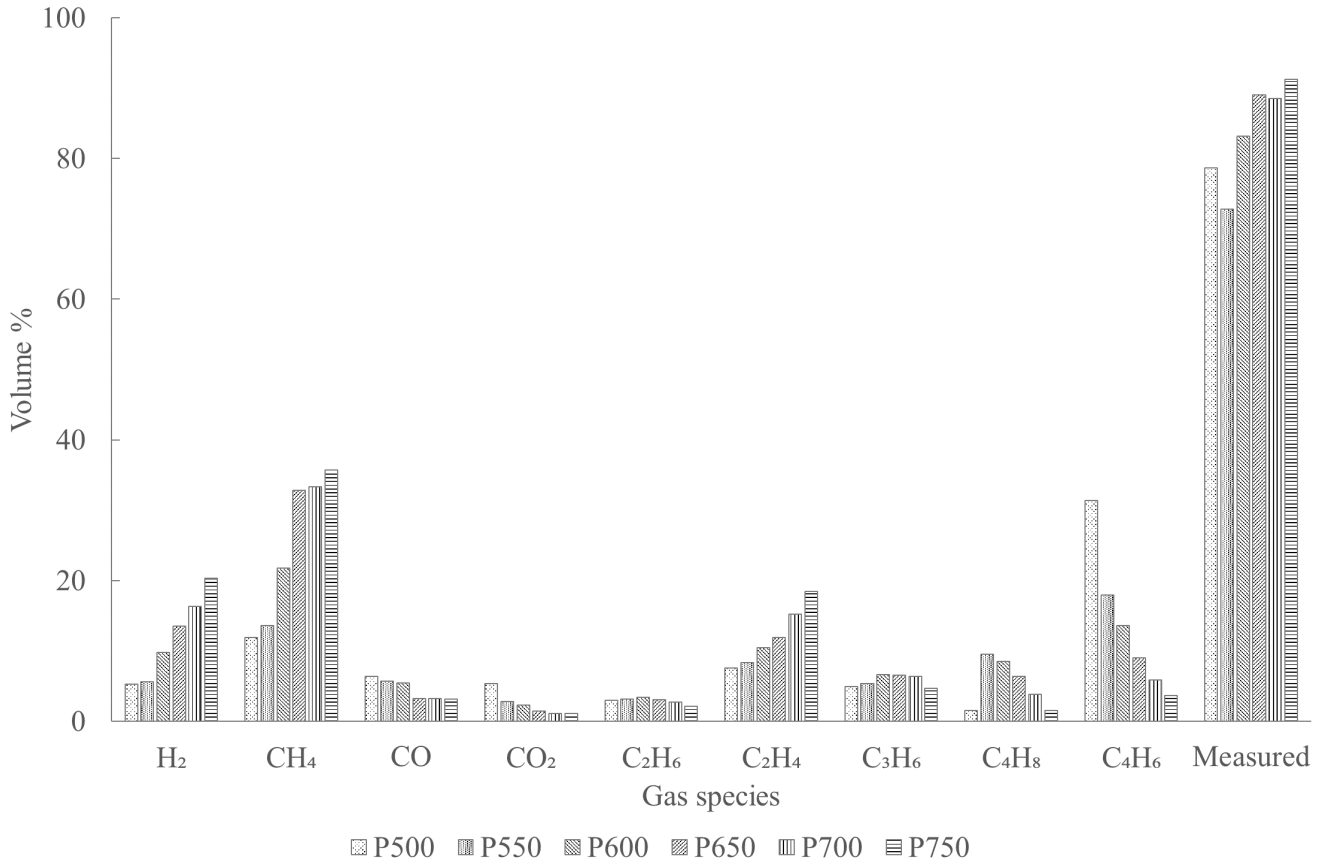


Hydrogen-to-Carbon atomic ratio



Sulfur retention

Pyrolysis Gas Properties

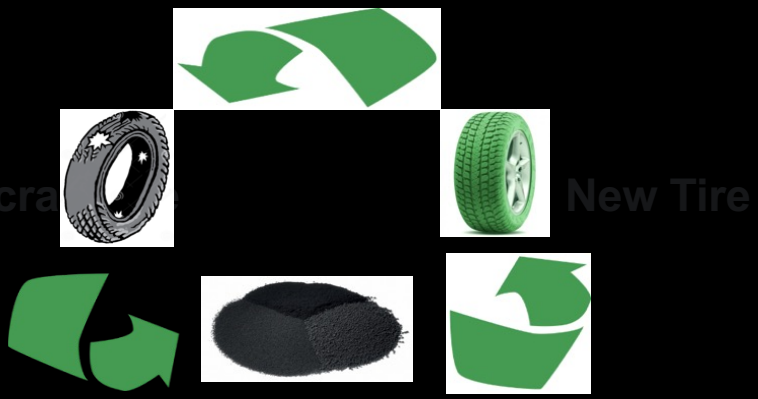


- Yield = 23-44 wt. %
- HHV = 44 MJ/kg
  [42-55 MJ/kg for natural gas]

Volumetric composition

Concluding remarks

- New reactor developed for flash pyrolysis of waste tires
- High-value CB product close to N660 quality
- Patent filed by Continental/UTwente
- Implementation in practice via Continental and 3rd party



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