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Investigation of Cost Reduction Options for BFB Gasification

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CanmetENERGY

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NRCan: Bioenergy Program at CanmetENERGY-Ottawa (CE-O)

Increased utilization of biomass will allow Canadian industries to lower their carbon footprint while using secure, local, sustainable resources. Communities also derive economic and employment benefits from increased use of local resources. CE-O advances these national interests through innovation on conversion of biomass for energy and production of solid, liquid, and gaseous fuels.



Objectives

- CanmetENERGY-Ottawa is investigating the potential to reduce the cost of producing clean synthesis gas by:
 - thermal and physical feedstock pre-treatment
 - low-cost catalysts for tar reduction
- Overcome barriers to the deployment of advanced biofuels through low complexity, low capital cost, clean synthesis gas production at scales of 250-2000 odt/day of biomass.



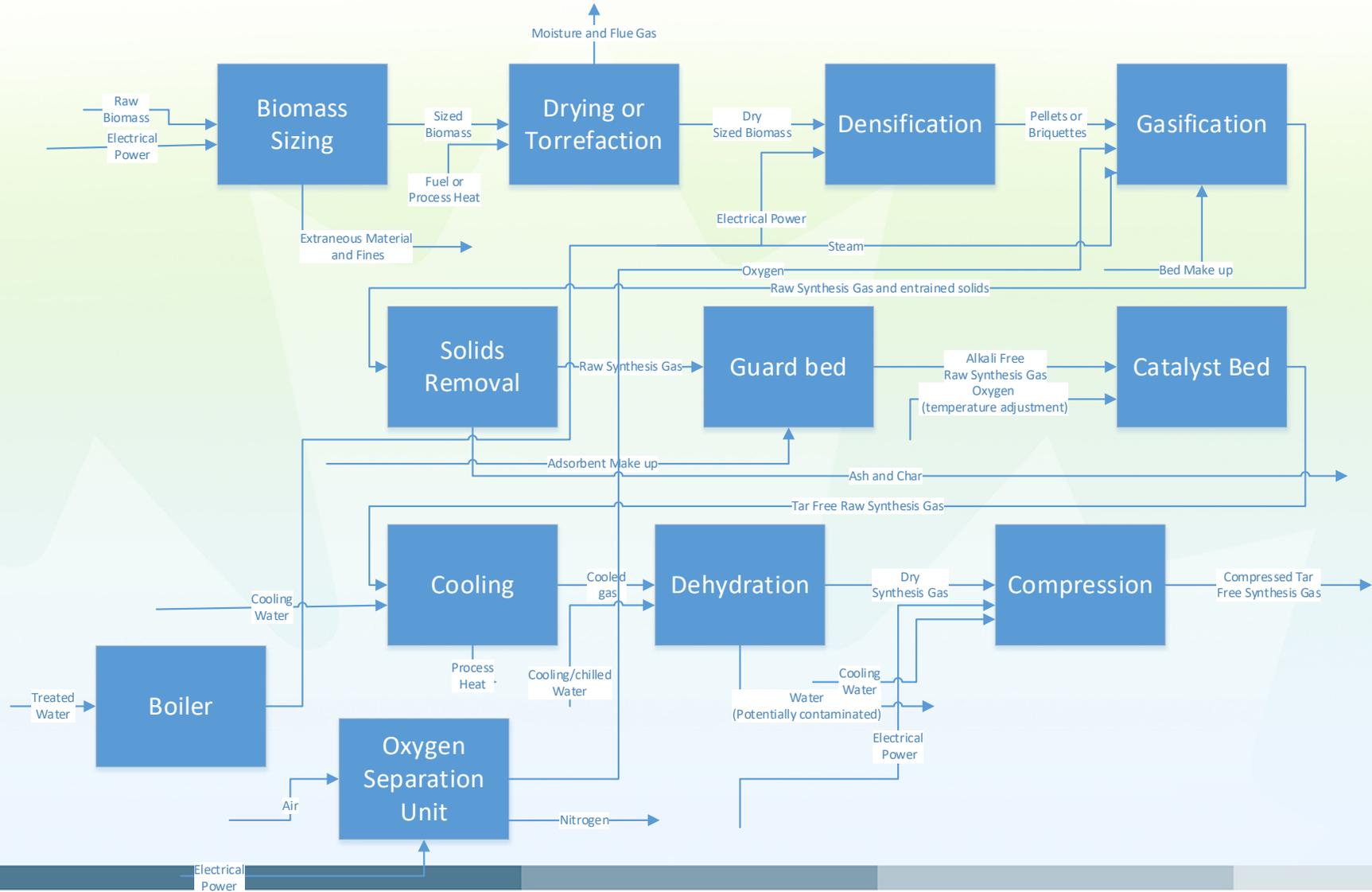
Presentation Overview

- Steam-oxy gasification of torrefied and carbonized feedstocks to evaluate effect on tar production.
- Application of a low cost three-way catalyst for catalytic tar removal.
- Design and commissioning of a 50 kW steam/oxygen-fed gasifier pilot plant with integrated pre-treatment and catalyst testing.

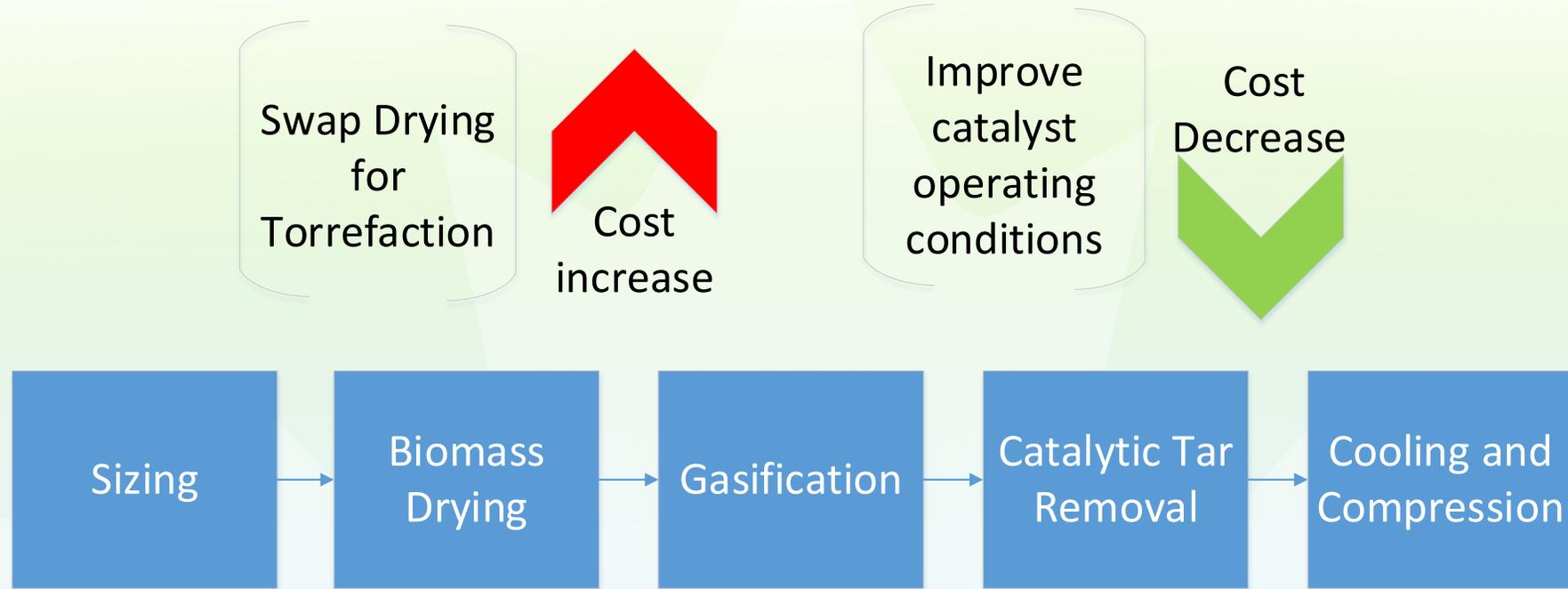


Process Details

Biomass gasification and synthesis requires the integration of many unit operations.



Concept Overview



Under what conditions or processing scenarios is a net benefit achieved?



Catalytic Tar Cracking

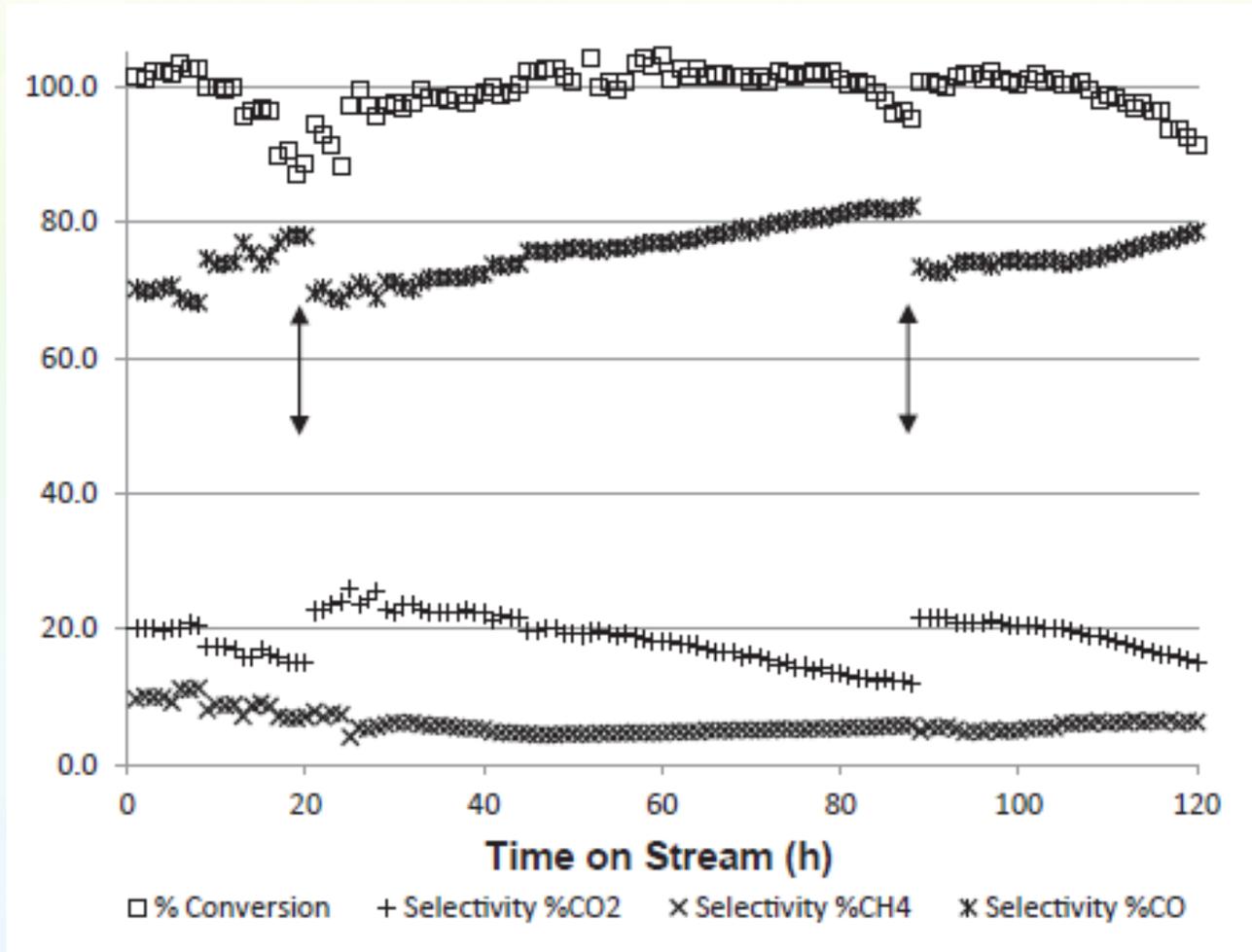
- CE-O has assessed the performance of a commercial three-way automotive catalyst for in situ destruction of biomass gasification tars

Assessing tar removal in biomass gasification by steam reforming over a commercial automotive catalyst

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Catalytic Tar Cracking

- PGM catalyst endured ~60 h continuous operation at 700°C at ~5000 ppm tar before deactivating.
- Catalyst could be regenerated by calcining in air at 500°C.
- SEM analysis indicated that carbon deposition is likely cause of deactivation.

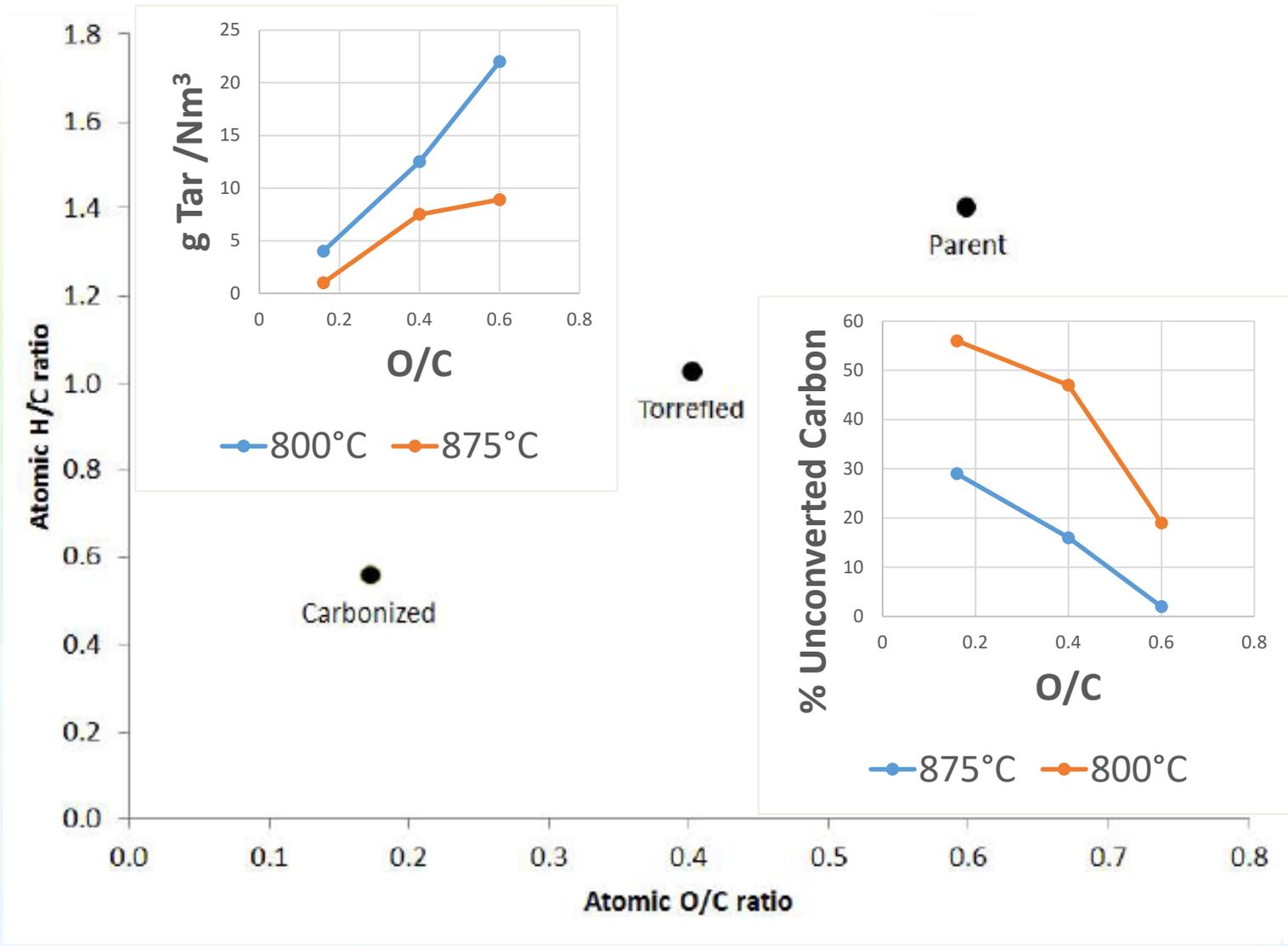


Easing the tar burden

- “Many of the problems in wood gasification are related to the properties of the fuel”-Prins et al. 2006*.
- CanmetENERGY has investigated torrefaction or carbonization pre-treatment to reduce tar in raw syngas.
- Other potential advantages of torrefaction could be integrated into a biorefinery

**"More efficient biomass gasification via torrefaction"*
Energy 31 (2006) 3458–3470





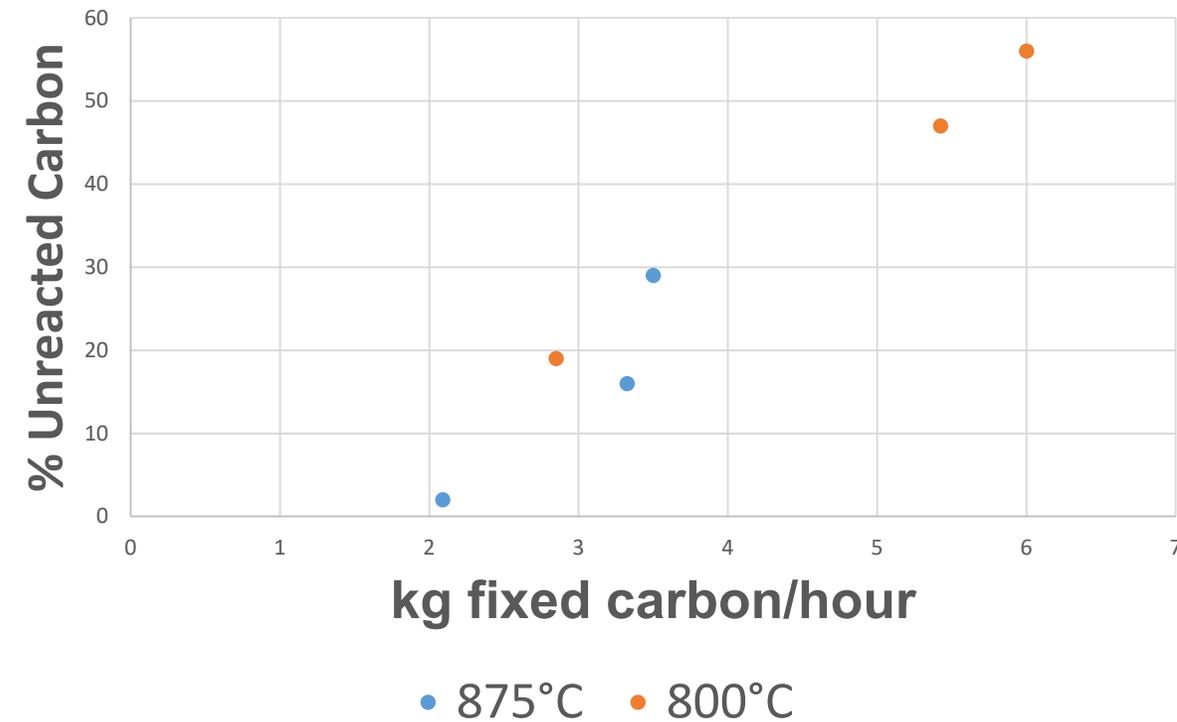
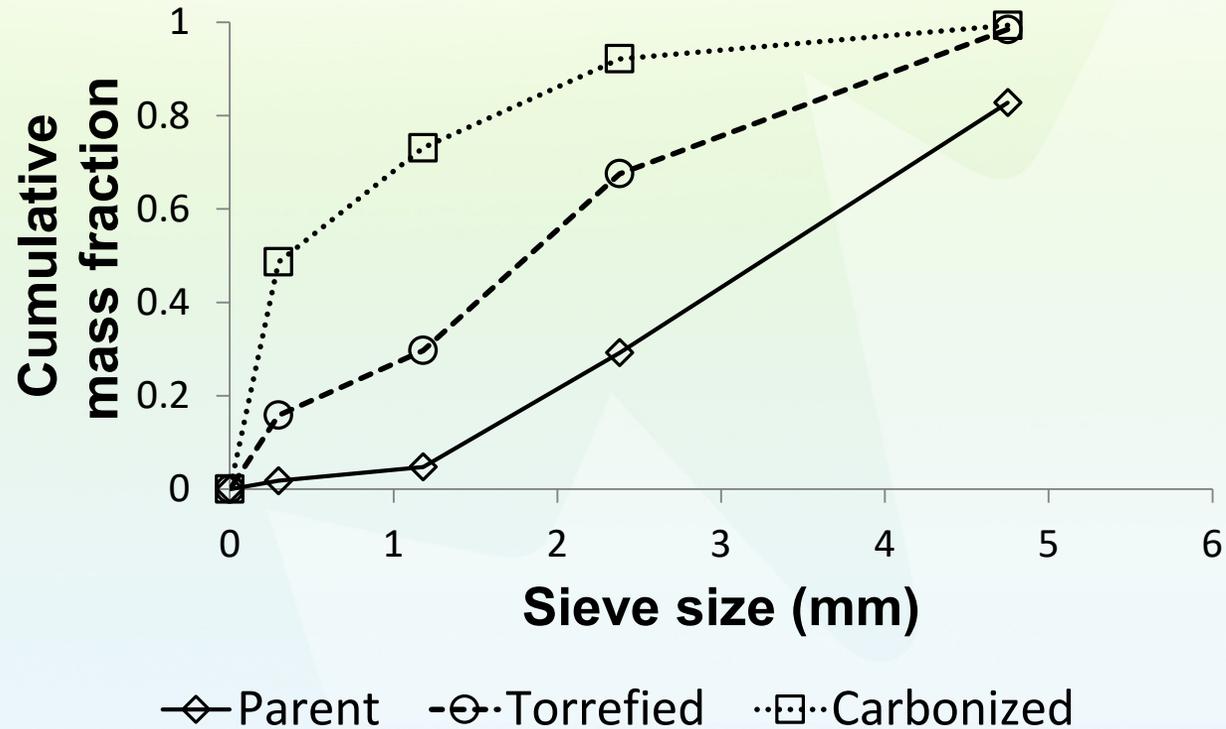
Easing the tar burden

- Thermal pre-treatment lowers the volatile content of the fuel.
- Volatile material provides the precursors for the tar compounds; the tar content of the raw gas is reduced.
- Extent of pre-treatment can be used to tune raw tar from >10 g/Nm³- <1 g/Nm³.
- Composition of the tar is affected (proportion of phenols rises).
- Reduced reactivity of feed-increased carbon hold up-increased elutriation.



Unconverted Carbon

More fixed carbon + more fines = more unreacted carbon

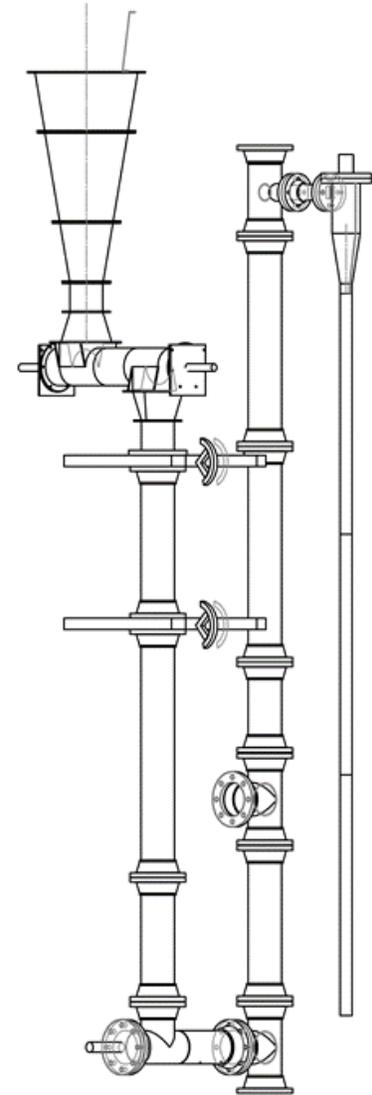


- Solutions: densify the fuel, increase the reactivity of the gasification mixture
- Solids recycle or biochar



Integrating the concepts

- CE-O is commissioning a 150 kW steam-oxygen BFB gasifier pilot plant.
- A platform to test catalyst performance and limits.
- Determine what processing steps are required to operate the catalyst e.g. guard beds, additives.
- Estimate parameters for determining the influence of torrefaction on the cost of producing clean synthesis gas.



Next Steps: Pilot Plant Integration



- Key question: Is the benefit of reduced tar production worth the cost of torrefaction?
- What is the degree (mass loss) of torrefaction where the greatest net benefit is achieved?

Important Factors:

- carbon hold-up
- steam consumption-
- elutriation
- cold gas efficiency



Thank you!

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