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Production of tailored syngas for Dimethyl Ether synthesis by sorption enhanced gasification

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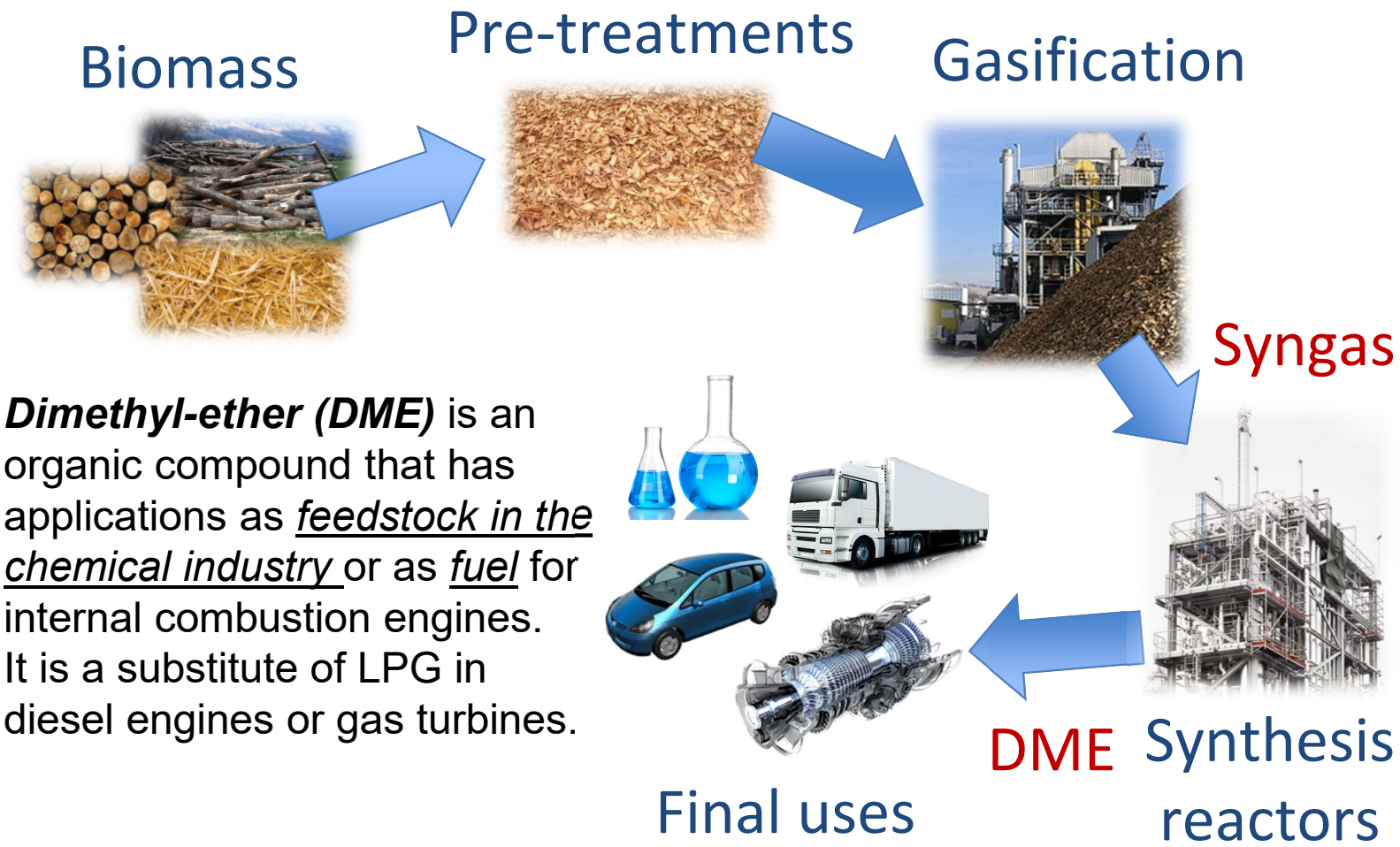
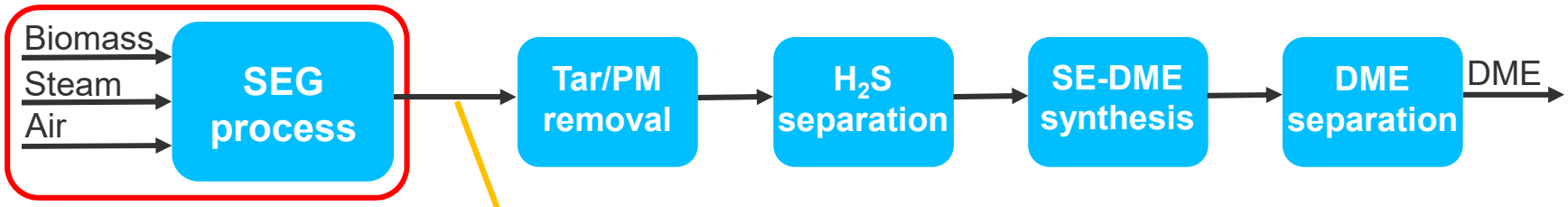
Dimethyl ether production from biomass



Dimethyl-ether (DME) is an organic compound that has applications as *feedstock in the chemical industry* or as *fuel* for internal combustion engines. It is a substitute of LPG in diesel engines or gas turbines.

FLEDGED project: Novel biomass to DME process



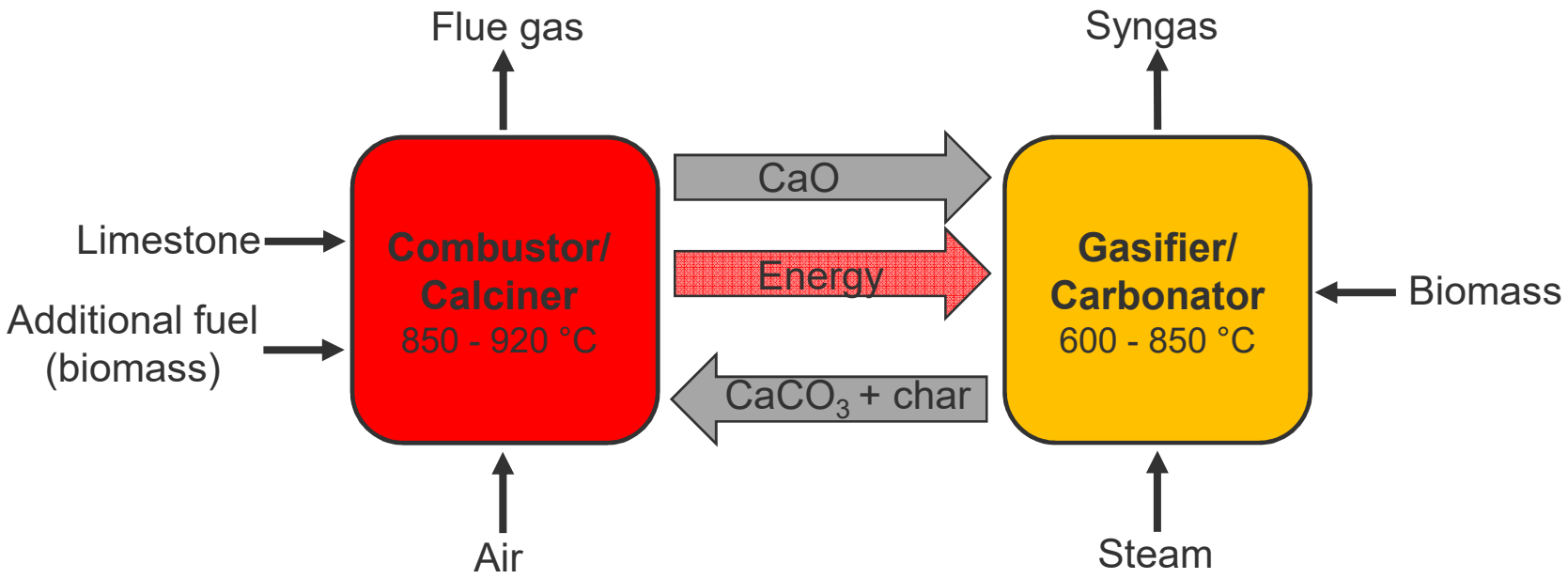
Optimal syngas for DME synthesis:

- **M-Module of 2**
  - Optimal for reactions to DME
- **Low CH_4 concentration**
  - CH_4 is inert in the SE-DMES process
- …

$$M = \frac{H_2 - CO_2}{CO + CO_2}$$

FLEDGED – FLexible Dimethyl ether production from biomass Gasification with sorption enhancED processes
SEG – Sorption enhanced gasification
PM – particulate matter

SEG process



Combustor/Calciner

- Calcination:

$CaCO_3 \longrightarrow CaO + CO_2$ $\quad \Delta h_R > 0$

Gasifier/Carbonator

- Carbonation:

$CaO + CO_2 \longrightarrow CaCO_3$ $\quad \Delta h_R < 0$

- Watergas

$CO + H_2O \longrightarrow CO_2 + H_2$ $\quad \Delta h_R < 0$

Influence of gasification temperature on the syngas composition (M module)

Selina Hafner M.Sc.

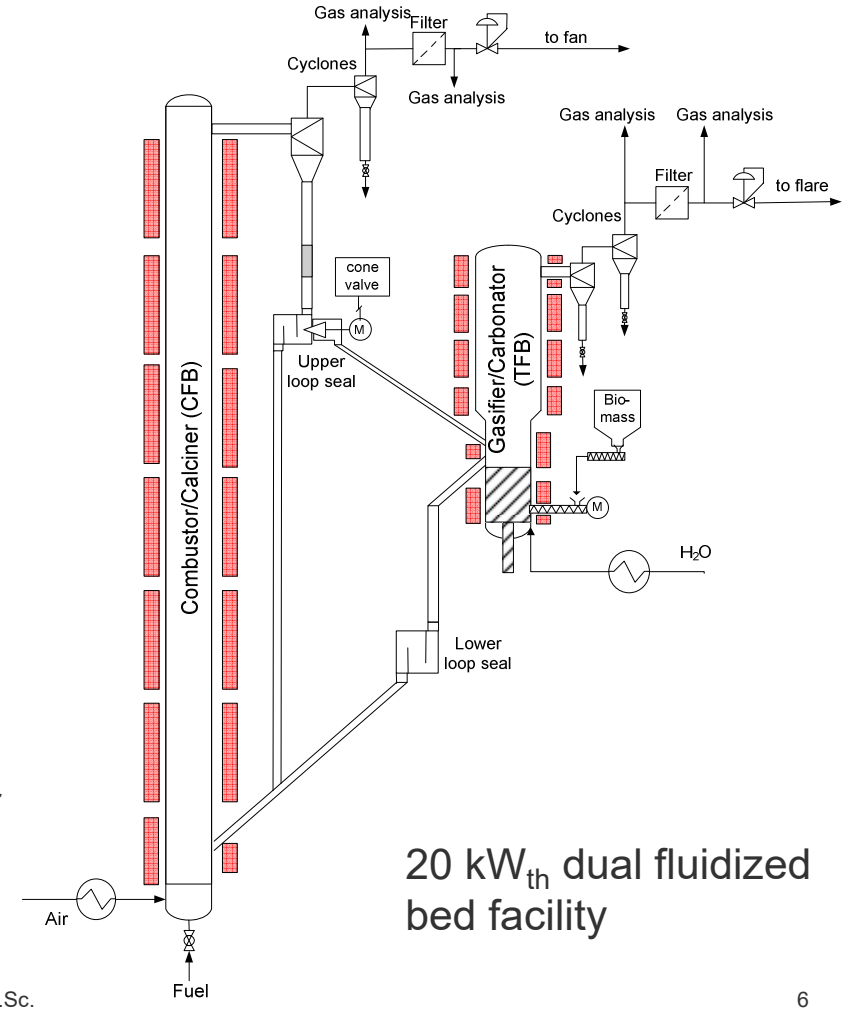
SEG process investigations – experimental setup

20 kW_{th} dual fluidized bed facility

- Technical data:

	Combustor/ Calciner	Gasifier/ Carbonator
Reactor height	12.4 m	3.5 m
Reactor diameter	70 mm	150 mm
Regime	CFB	TFB

- Electrically heated
- Gravimetric fuel dosing
- Gas analysis
  - Combustor: CO, O_2, CO_2, SO_2, NO_x
  - Gasifier: H_2, CO, CO_2, O_2, CH_4, C2-C4, tar



20 kW_{th} dual fluidized bed facility

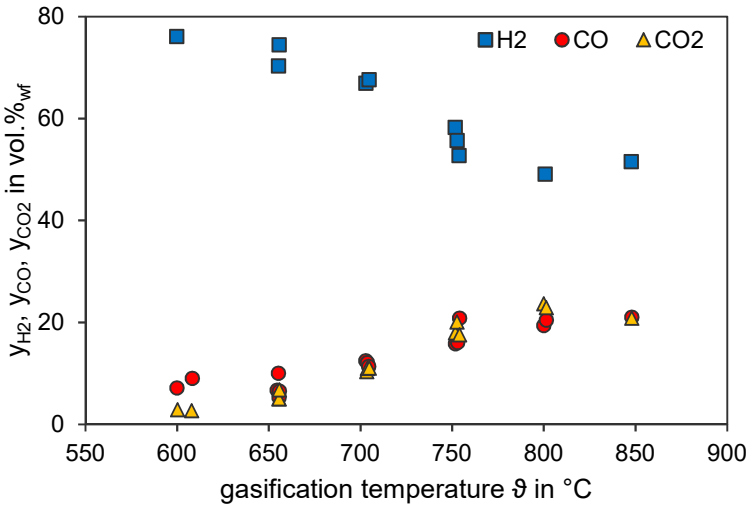
SEG process investigations – experimental setup

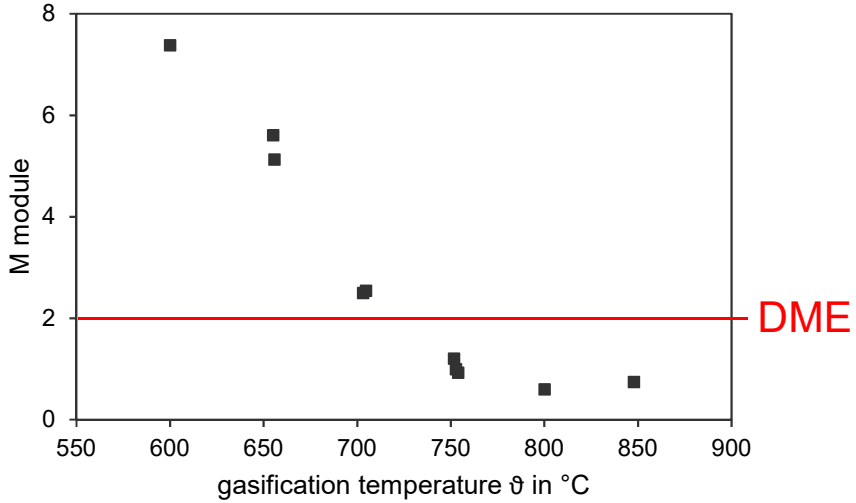
Operational conditions

- Fuel: Wood Pellets (ENplus A1)
- Sorbent: limestone (d_P = 300 – 600 µm)
- Gasifier/ Carbonator temperature: 600 – 850 °C
  - For each temperature steady operational condition for 1 – 2 h
- Combustor/ Calciner temperature: ~ 900 °C

SEG process – experimental results

Influence of the gasification temperature on M





- Increasing gasification temperature:
  - y_{H2} decreases
  - y_{CO} increases
  - y_{CO2} increases

→ Due to calcination/ carbonation equilibrium

- Increasing gasification temperature:
  - M-module decreases
- Gasification temperature of about 715 °C is needed for M = 2

Investigations on methane reduction in the syngas

Selina Hafner M.Sc.

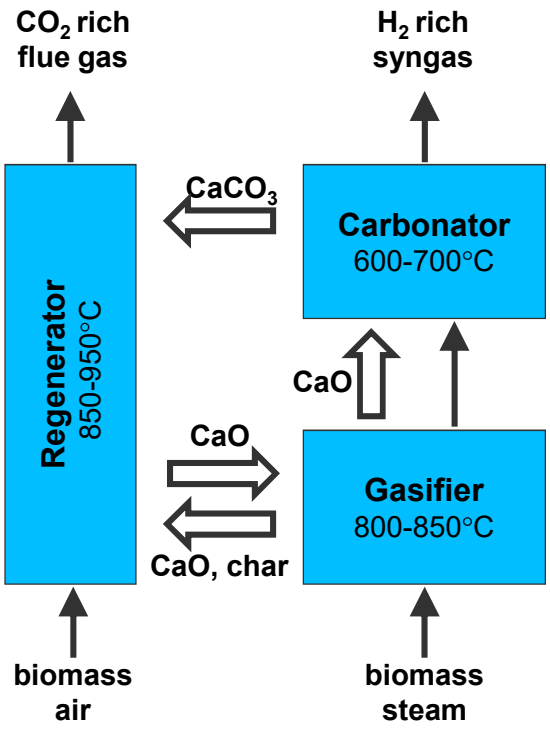
Methane reduction – SEG in 2 stages

1.) High temperature gasification

- Gasification temperature of 850 °C or higher
- For reduced methane formation
- Heat supply:
  - Circulation of hot bed material
  - Hot regenerator flue gases

2.) CO_2 capture at lower temperatures

- Temperature of 600 – 700 °C



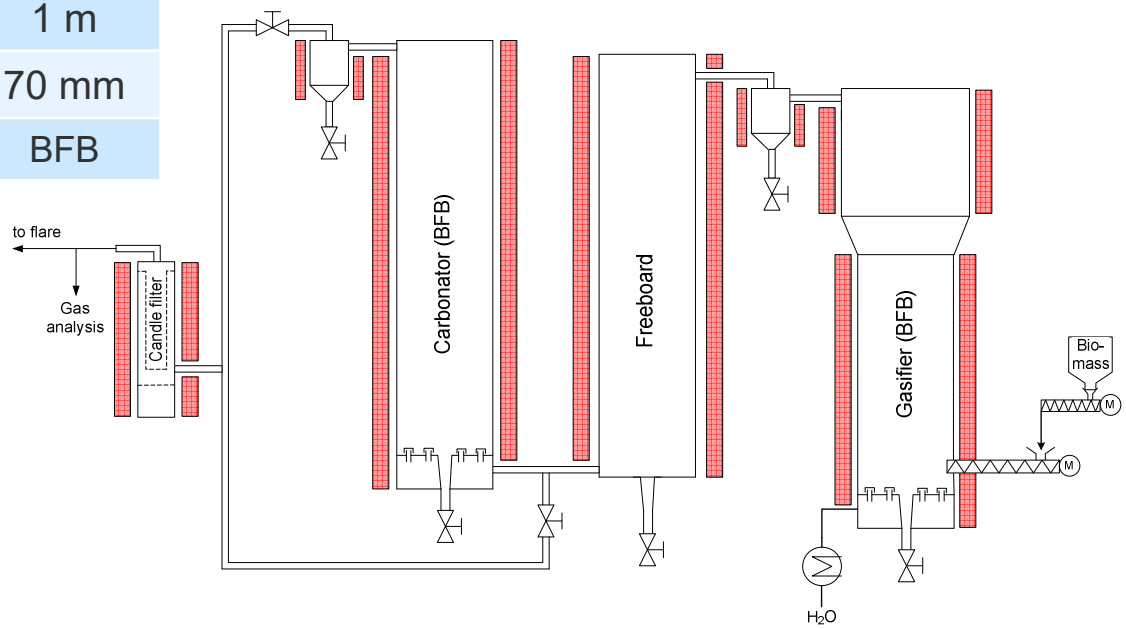
Methane reduction tests – experimental setup

8 kW_{th} dual fluidized bed facility

- Technical data:

	Carbonator	Gasifier
Reactor height	1 m	1 m
Reactor diameter	110 m	70 mm
Regime	BFB	BFB

- Electrical heated
- Gravimetric fuel dosing



Methane reduction tests – experimental setup

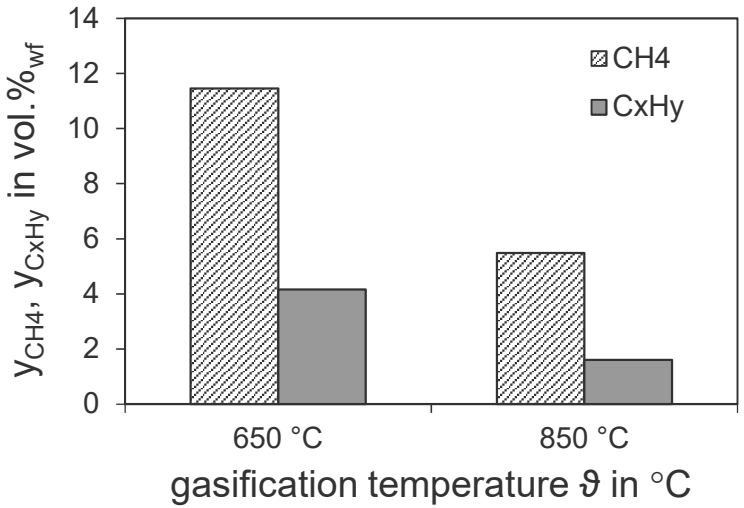
Operational conditions

- Semi-batch mode
- Fuel: Wood Pellets (ENplus A1)
- Sorbent: limestone (d_P = 300 – 600 µm)
  - Fully calcined at 850 °C
- Gasifier temperature: 650 and 850 °C

Methane reduction tests – experimental results

Influence of gasification temperature on the CH_4 and C_xH_y content

- Outlet concentrations gasifier:



- y_{CH4} and y_{CxHy} are strongly influenced by gasification temperature
- Two-stage SEG offers a possibility to operate SEG with all its benefits

Summary and outlook

- Syngas composition/ M module is strongly influenced by gasification temperature
- Gasification temperature of about 715 °C is needed for M = 2
- y_{CH4} and y_{CxHy} decreases with increasing gasification temperature
  → Two-stage SEG offers a possibility to operate SEG with all its benefits

- Demonstration of SEG process at pilot scale
- Use of waste material as fuel

Acknowledgement

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Thank you!

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