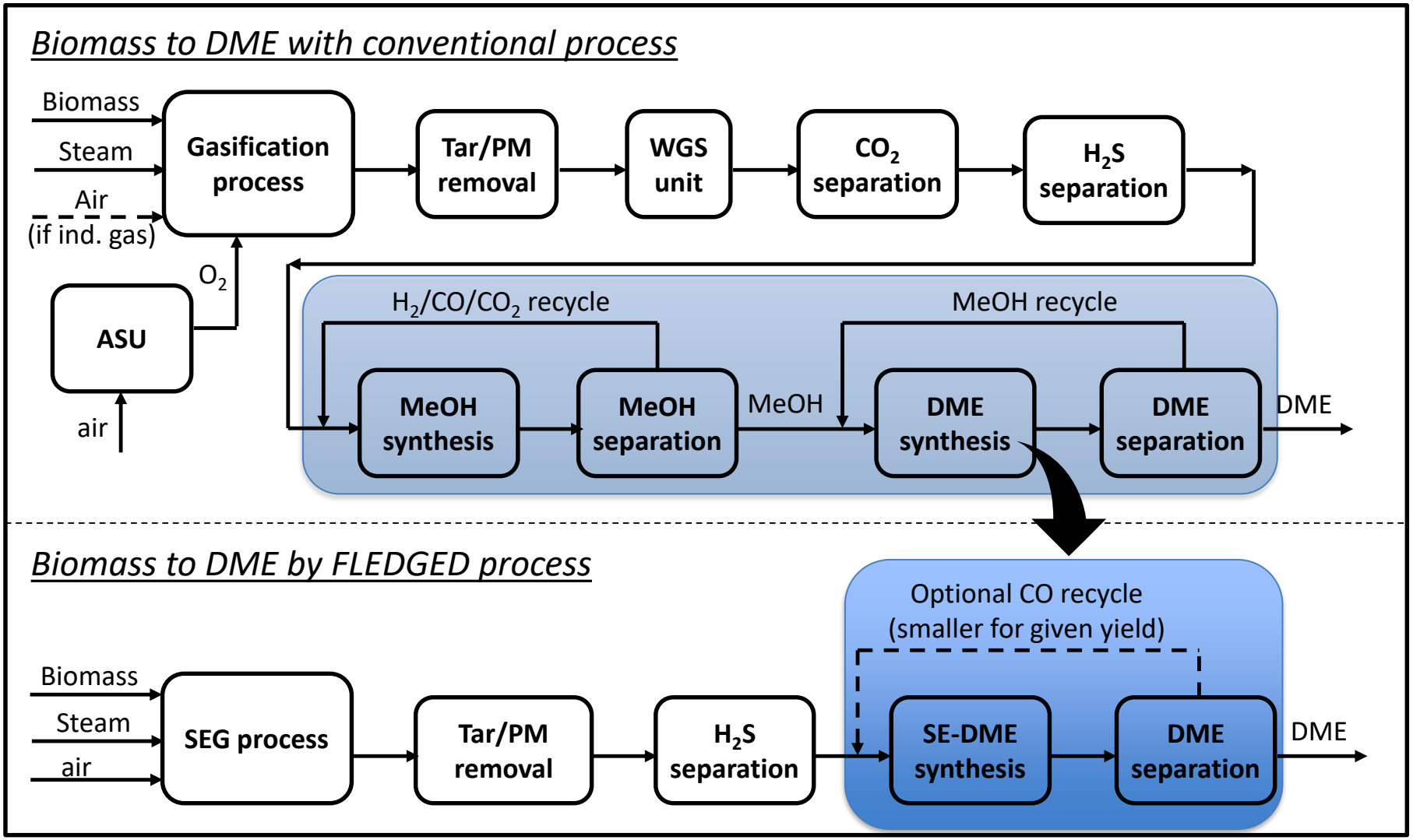
Sorption-Enhanced Dimethyl Ether Synthesis (SEDMES)

TNO

Process intensification: Sorption-Enhanced DME Synthesis



Process intensification: Direct DME Synthesis

Feed gas

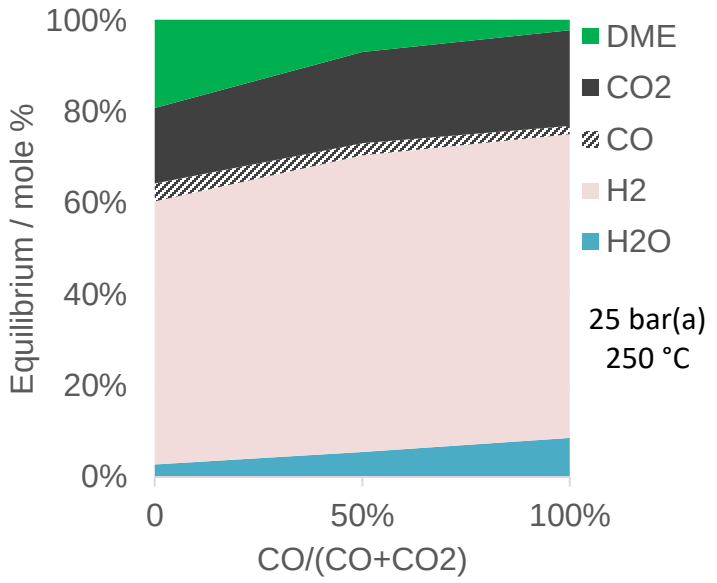
CO and CO_2 with stoichiometric H_2 ($M = \frac{[H_2]-[CO_2]}{[CO]+[CO_2]} = 2$)

Direct DME synthesis equilibrium

$2CO + 4H_2 \rightleftharpoons CH_3OCH_3 + H_2O$ (1)

$2CO_2 + 6H_2 \rightleftharpoons CH_3OCH_3 + 3H_2O$ (2)

$CO_2 + H_2 \rightleftharpoons CO + H_2O$ (3)



- Poor conversion per pass
- High CO_2 concentration product ($CO + H_2O \rightarrow CO_2 + H_2$)

Process intensification: Sorption-Enhanced DME Synthesis

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Sorption-enhanced DME synthesis

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- High conversion per pass
- High CO concentration product ($CO_2 + H_2 \rightarrow CO + H_2O$)

Henry Louis Le Chatelier (1850 – 1936)

Process intensification: Sorption-Enhanced DME Synthesis

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Sorption-enhanced DME synthesis

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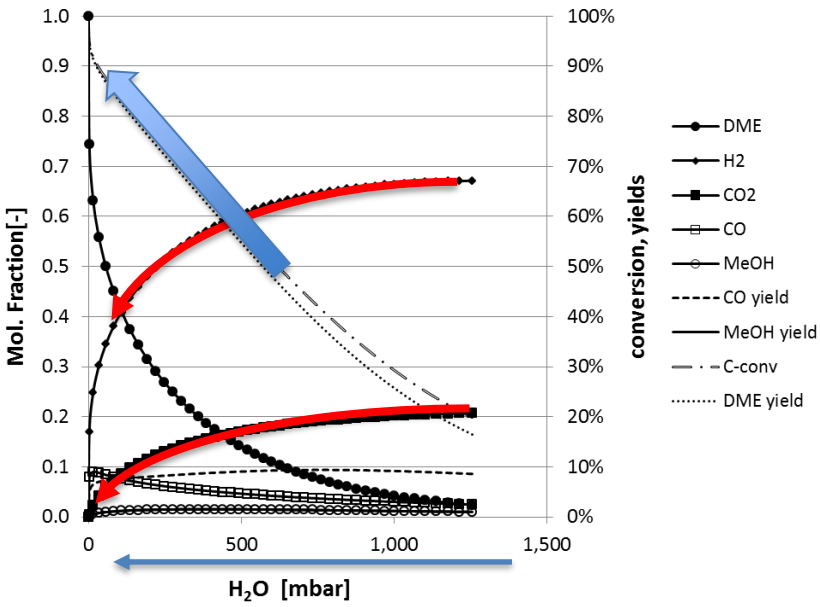

- High conversion per pass
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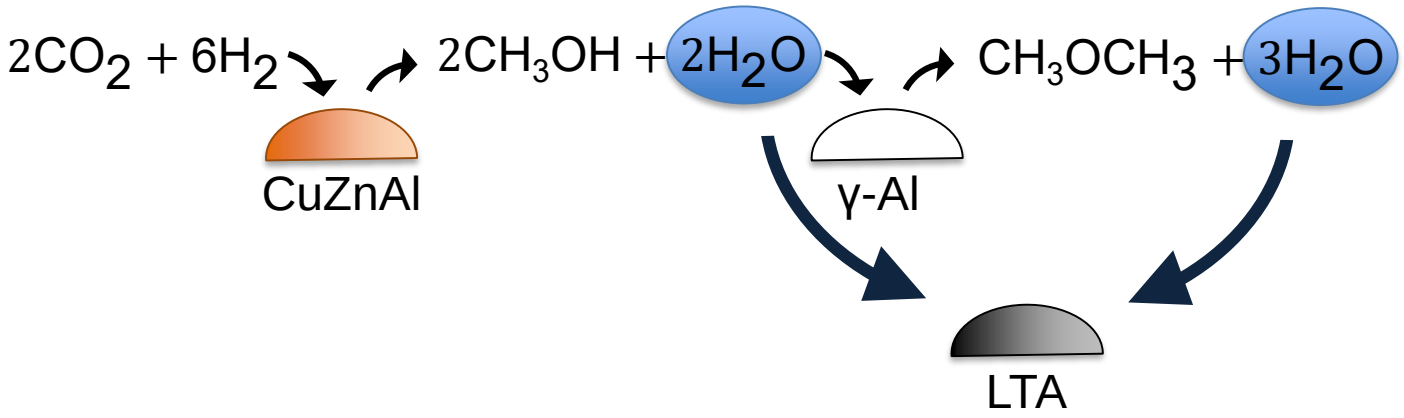
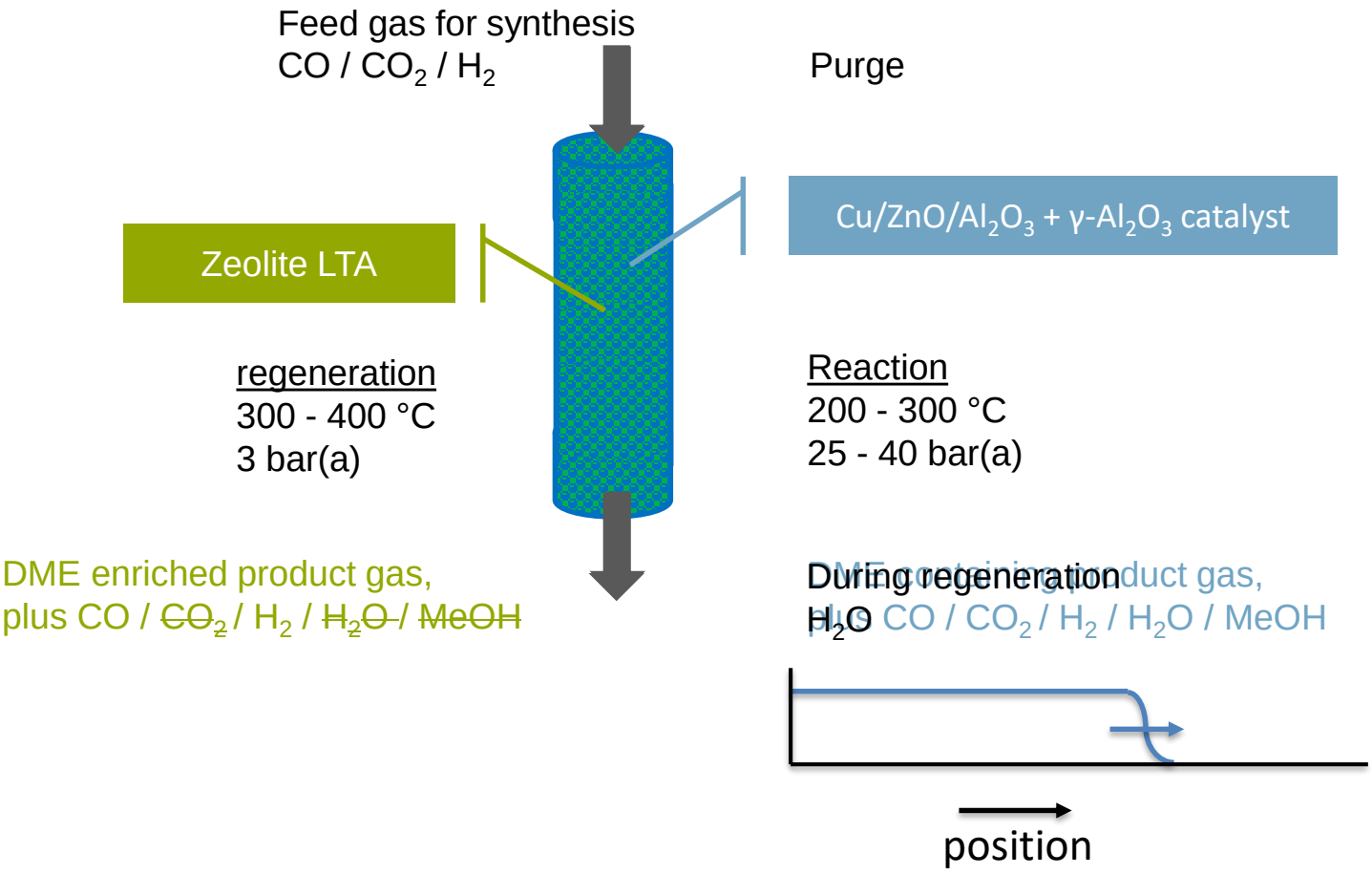
SEDMES

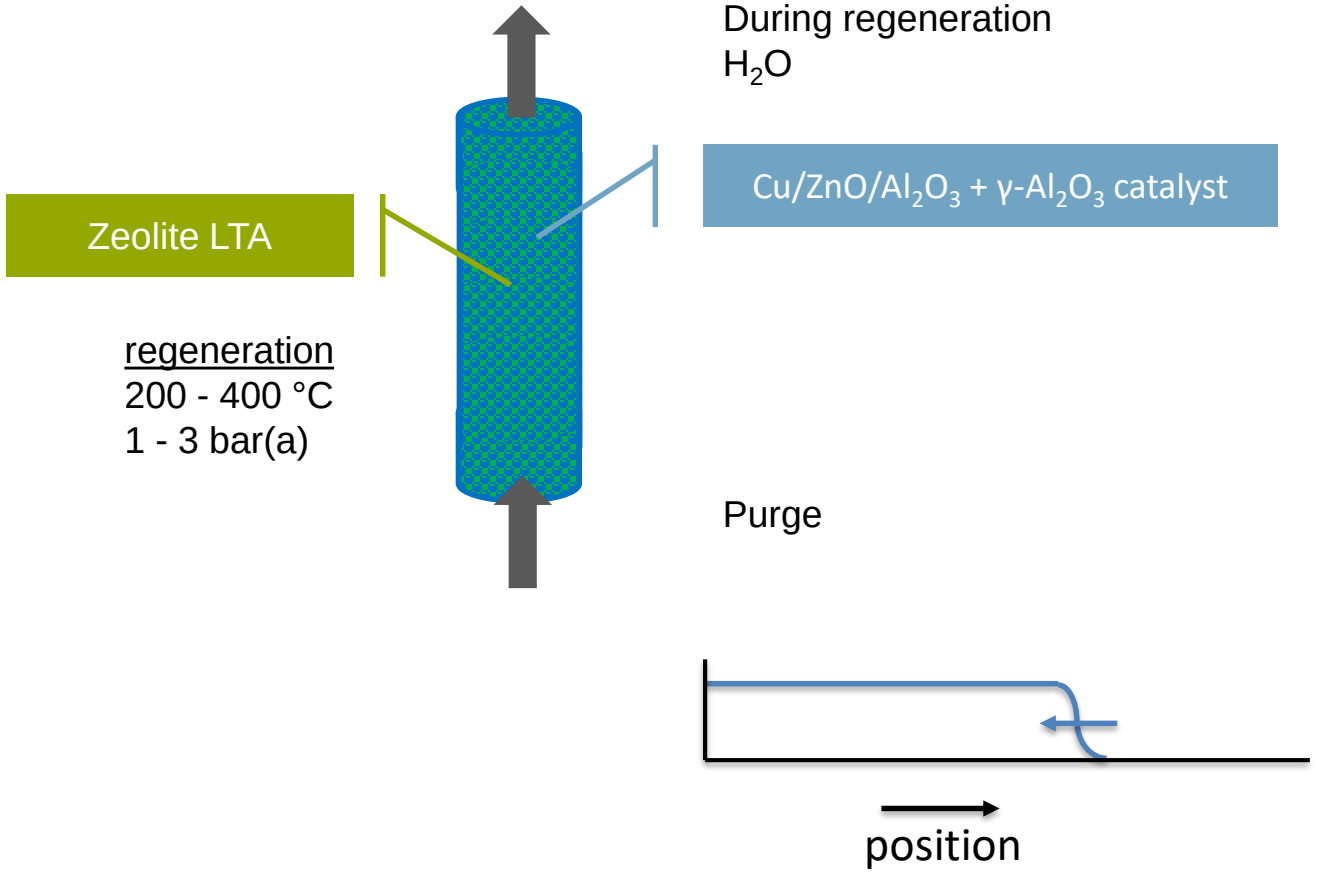
In sorption-enhanced DME synthesis, SEDMES, the equilibrium of direct DME synthesis is shifted by using a physical adsorbent



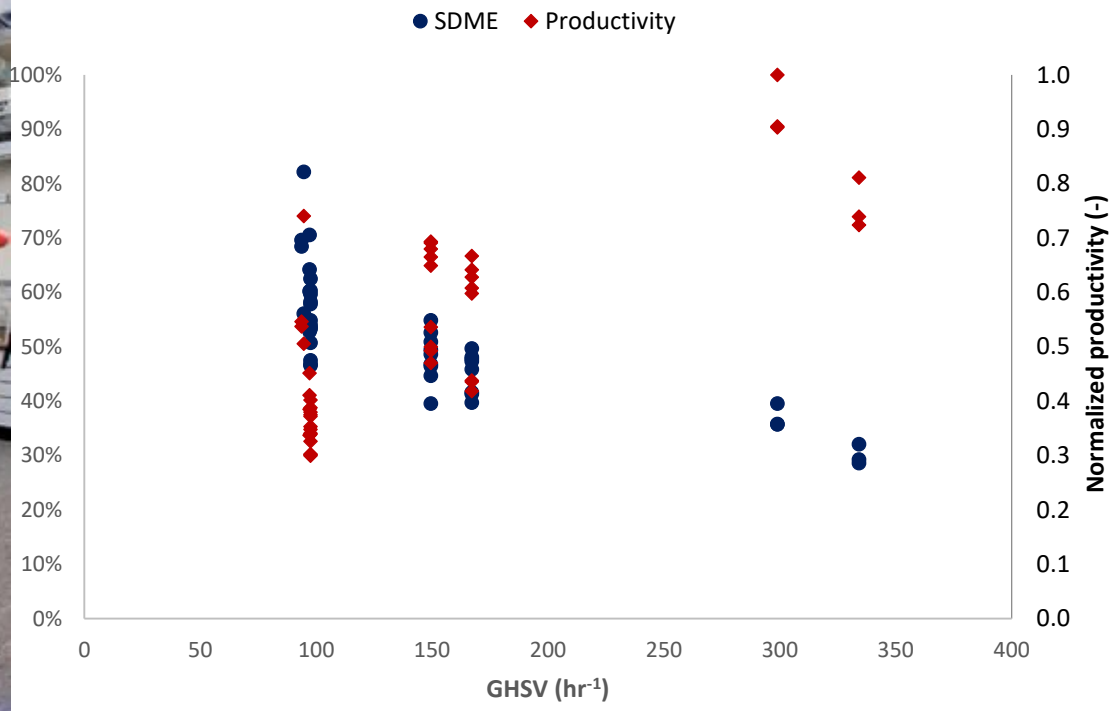
SEDMES: Experimental validation



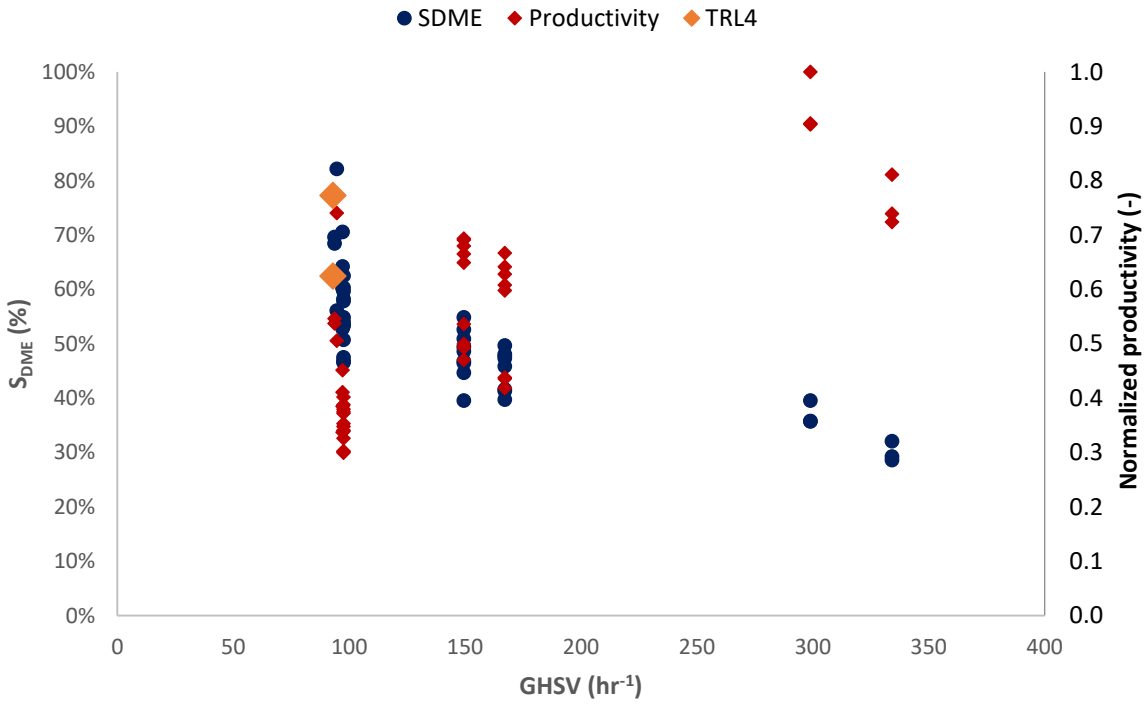
SEDMES: Experimental validation



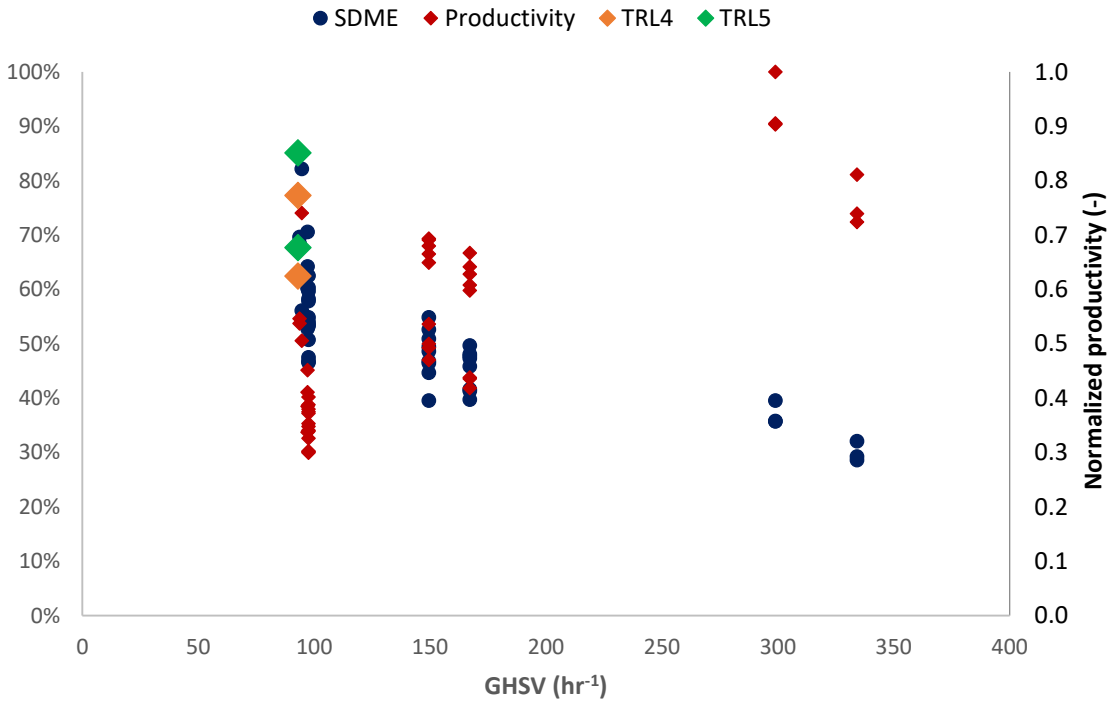
SEDMES: Experimental validation



SEDMES: Experimental validation

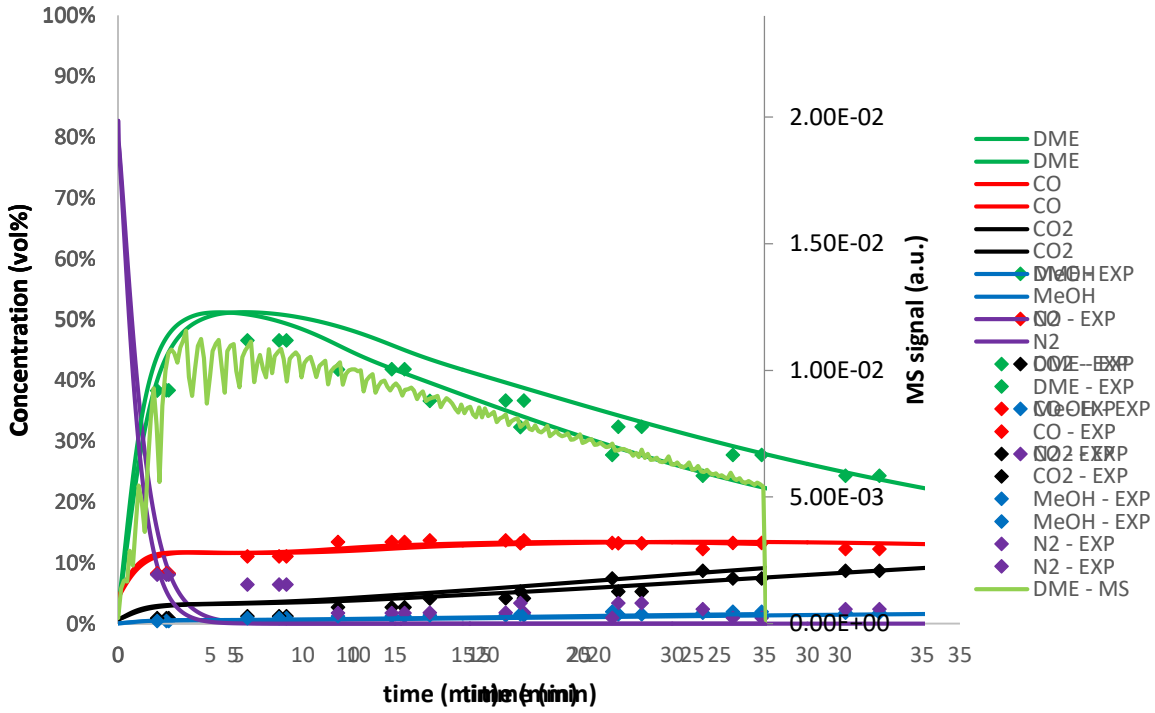


SEDMES: Experimental validation



SEDMES: Modelling

SEDMES model validated at TRL4



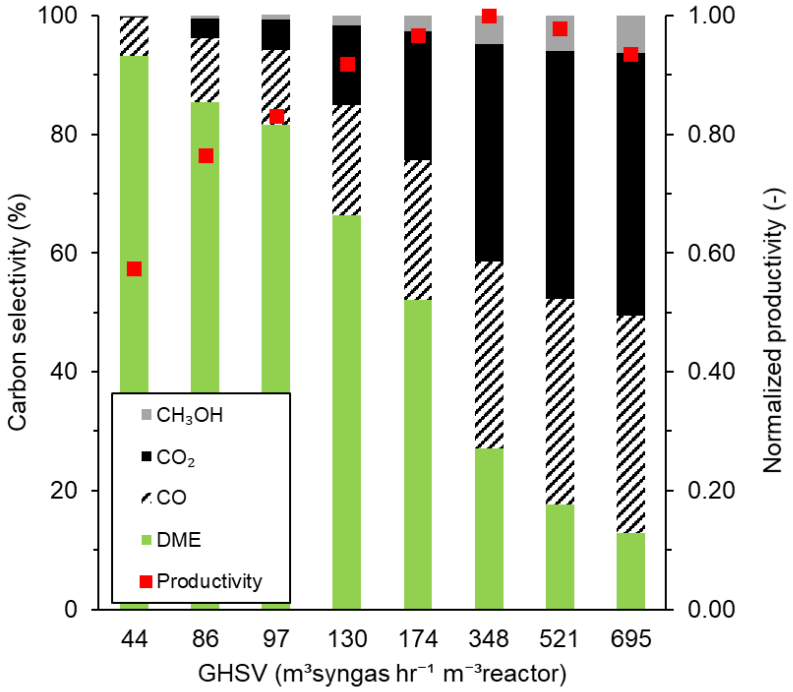
SEDMES: Cycle design

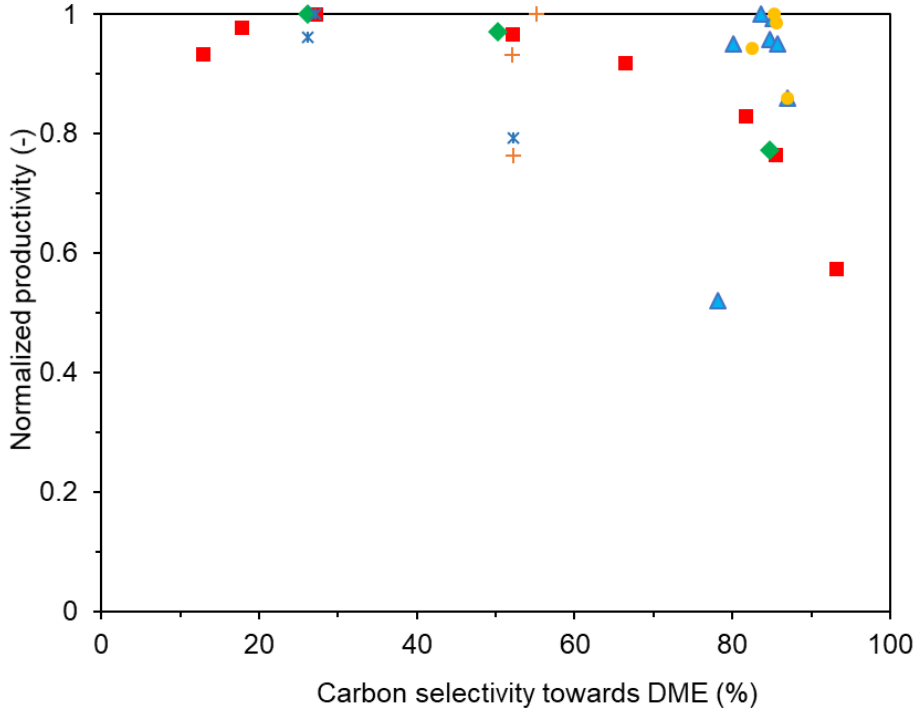
Column 1	ADS	PEQDN	BD	PURGE	PEQUP	REP
Column 2	REP	ADS	PEQDN	BD	PURGE	PEQUP
Column 3	PEQUP	REP	ADS	PEQDN	BD	PURGE
Column 4	PURGE	PEQUP	REP	ADS	PEQDN	BD
Column 5	BD	PURGE	PEQUP	REP	ADS	PEQDN
Column 6	PEQDN	BD	PURGE	PEQUP	REP	ADS

Optimization parameters:

- Gas hourly space velocity during adsorption, purge and repressurization step
- Cycle time
- Pressure equalization step(s)
- Gas recycling
- Operating conditions per step
- Adjusting boundary conditions

SEDMES: Cycle design





Typical for sorption-enhanced processes trade-off between carbon selectivity towards DME and productivity

SEDMES: Outlook

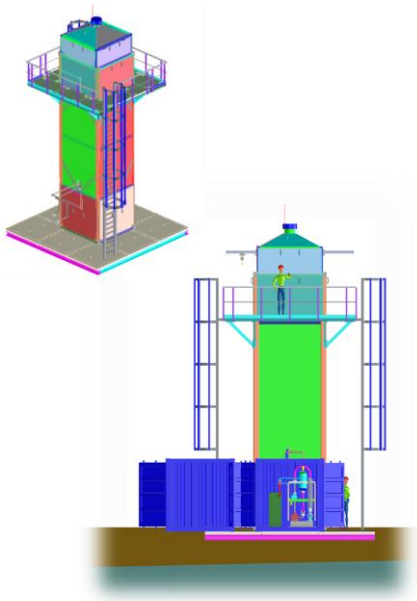
✓ SEDMES process validated in relevant environment

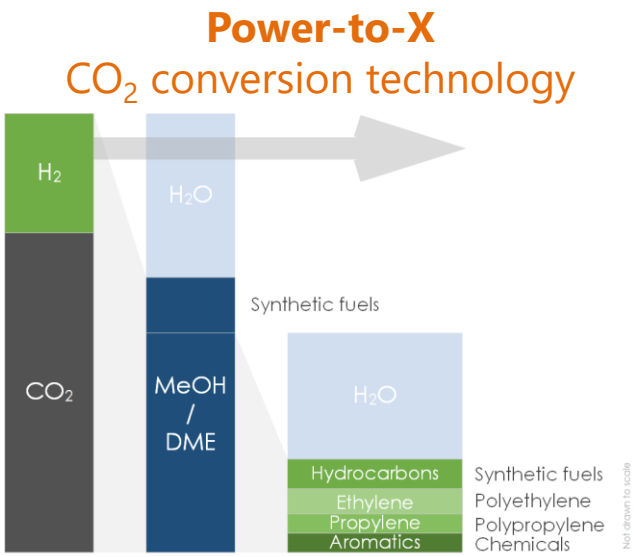
Now working towards biomass gasification and P2X as use cases

Biomass gasification
business case in Fledged

Power-to-X (CO_2 to DME)
business case in
Interreg project E2C

Constructing
pilot demonstrator





Interreg 2 Seas Mers Zeeën
European Regional Development Fund

e2c

SEDMES: Conclusions

- Separation-enhanced synthesis technology offers intensified processes for economic valorisation of CO_2-rich syngas
- Sorption-enhanced DME synthesis, SEDMES, has been developed using commercially available materials
- Validated modelling framework has allowed to design and optimise the SEDMES process for Fledged case
- SEDMES technology validated in relevant multicolumn, environment (TRL5)

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