

UNIVERSITY OF TWENTE.

BIO-METHANE PRODUCTION VIA GASIFICATION

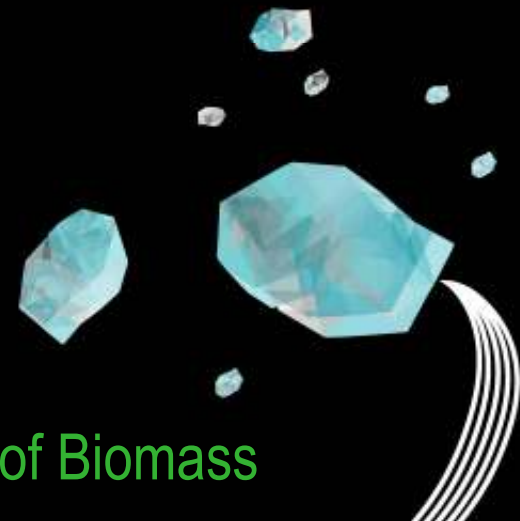
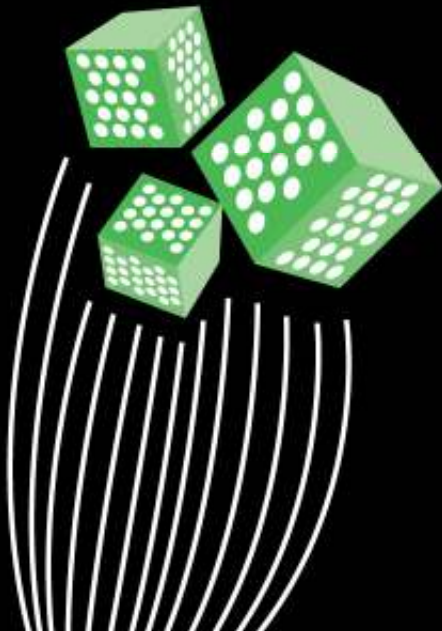
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Thermo-Chemical Conversion of Biomass

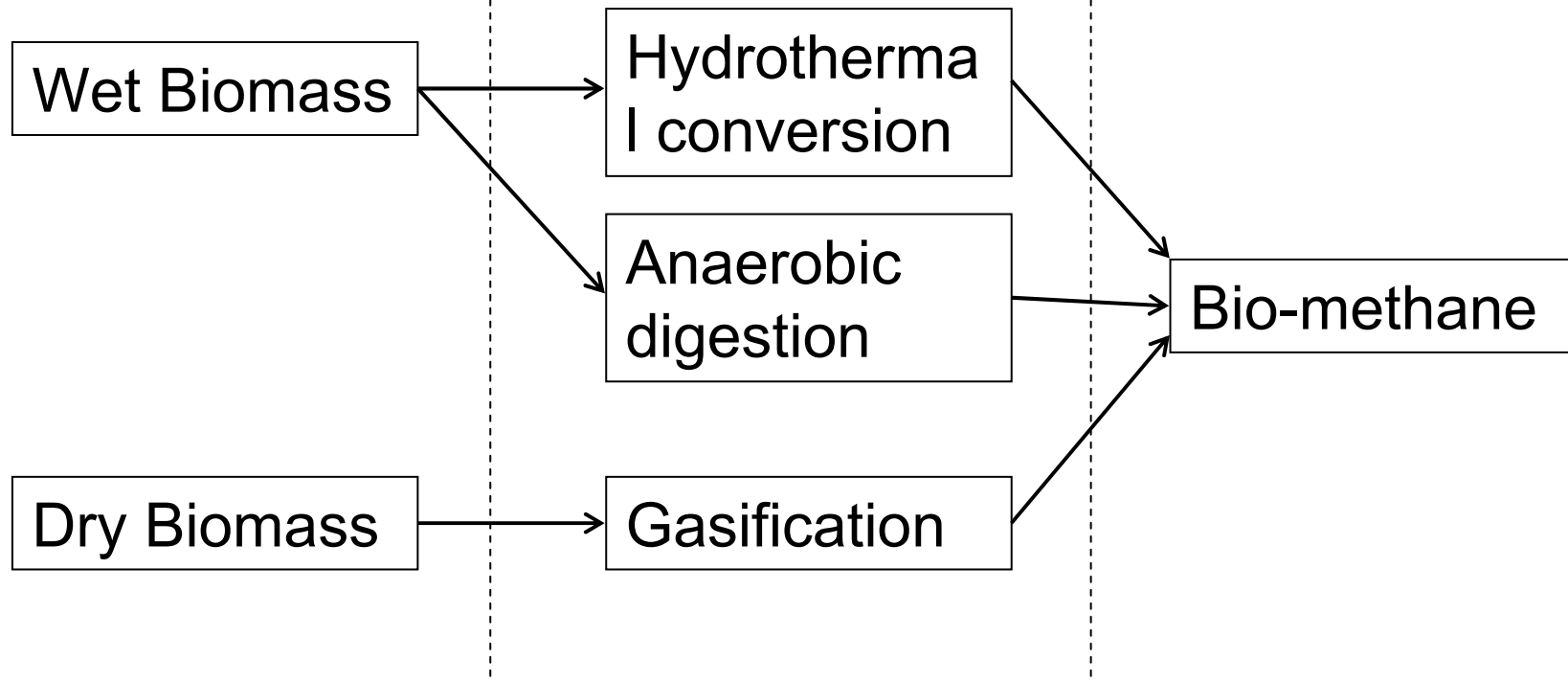


Methane from Biomass

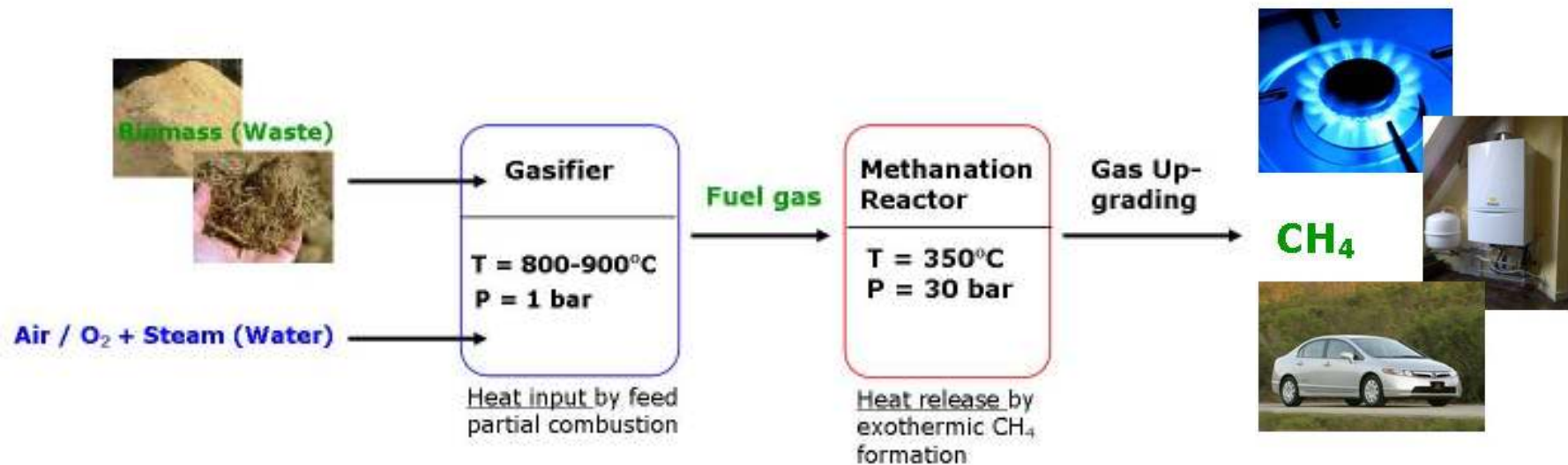
Biomass feed

Conversion route

Final product

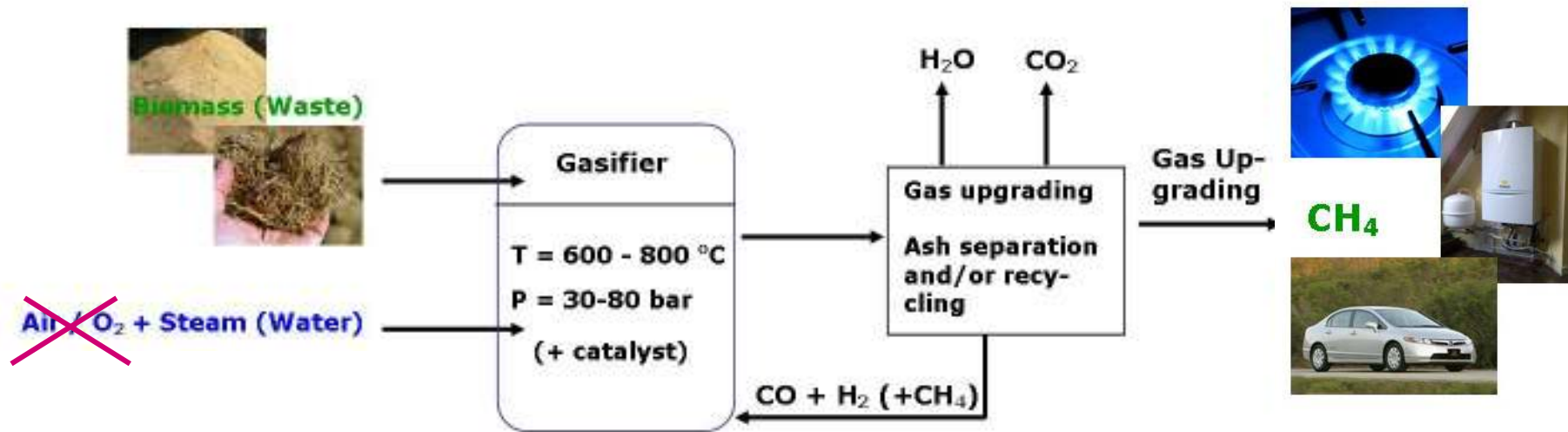


Biomass Gasification to Methane



- No heat integration possible between Gasifier and Methanation Reactor
- The high energy demand of the Gasifier requires air/O₂ feed

Biomass *Self-Gasification* to Methane



- Gasifier and Methanation reactor combined into a high-P/low T gasifier
- Possible gas and/or biomass ash recycle

Self-Gasification?

(Auto)catalytic

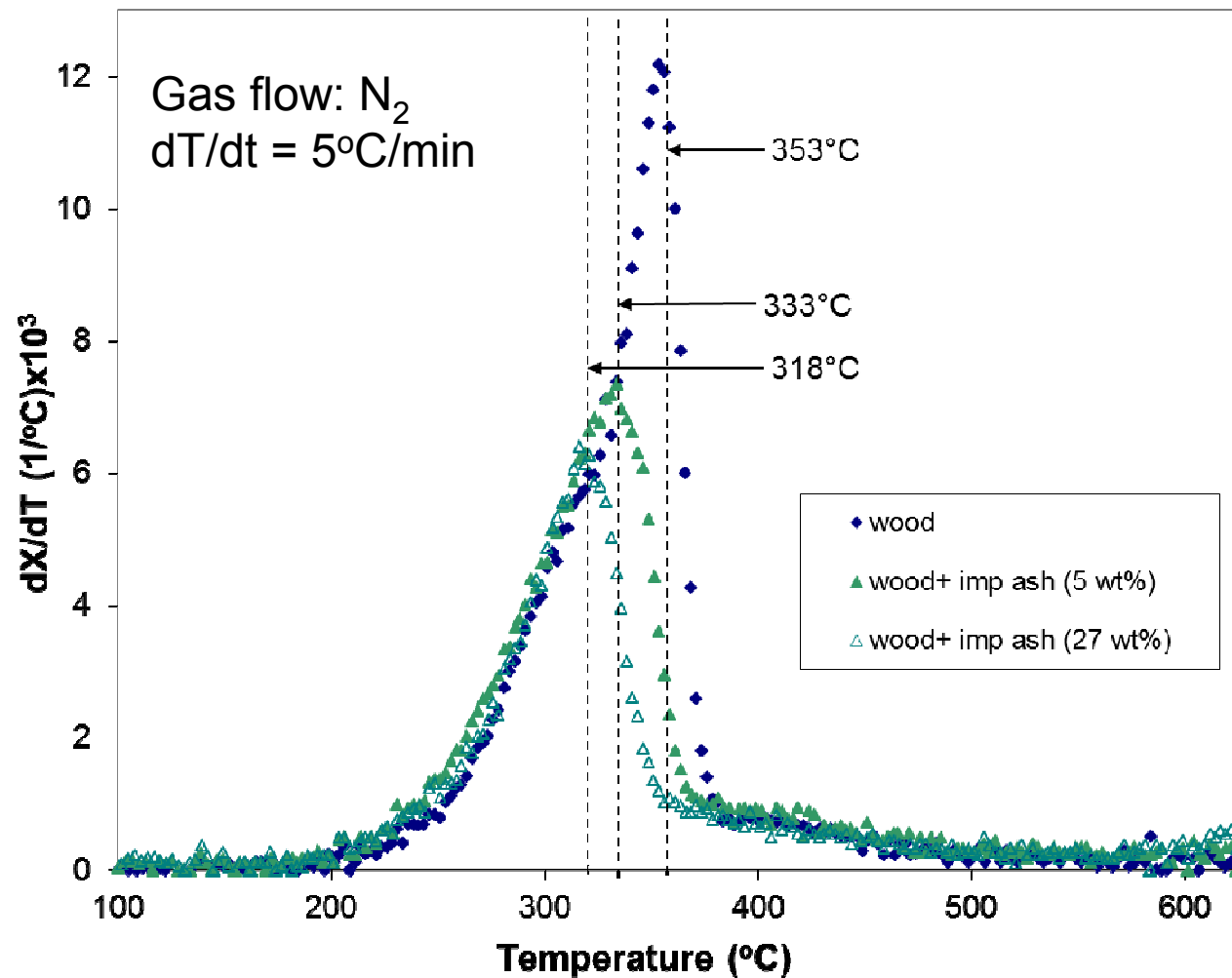
Biomass minerals
used as catalysts
in the process

+

Autothermal

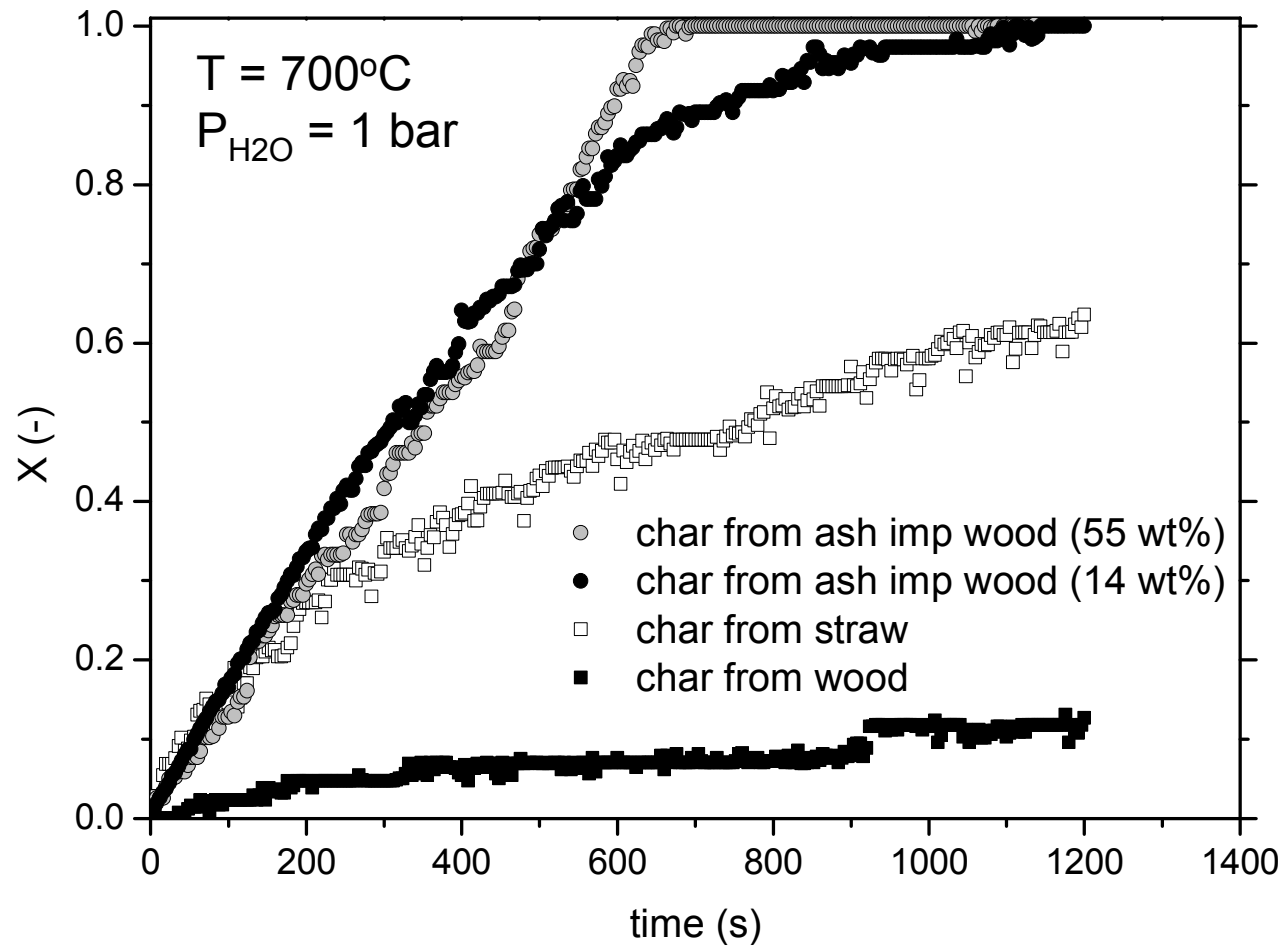
Heat **released** by
methanation =
Heat **demand** for
gasification

(Auto)catalytic I : Pyrolysis



Minerals in wood
(ash) catalyze the
pyrolysis reaction

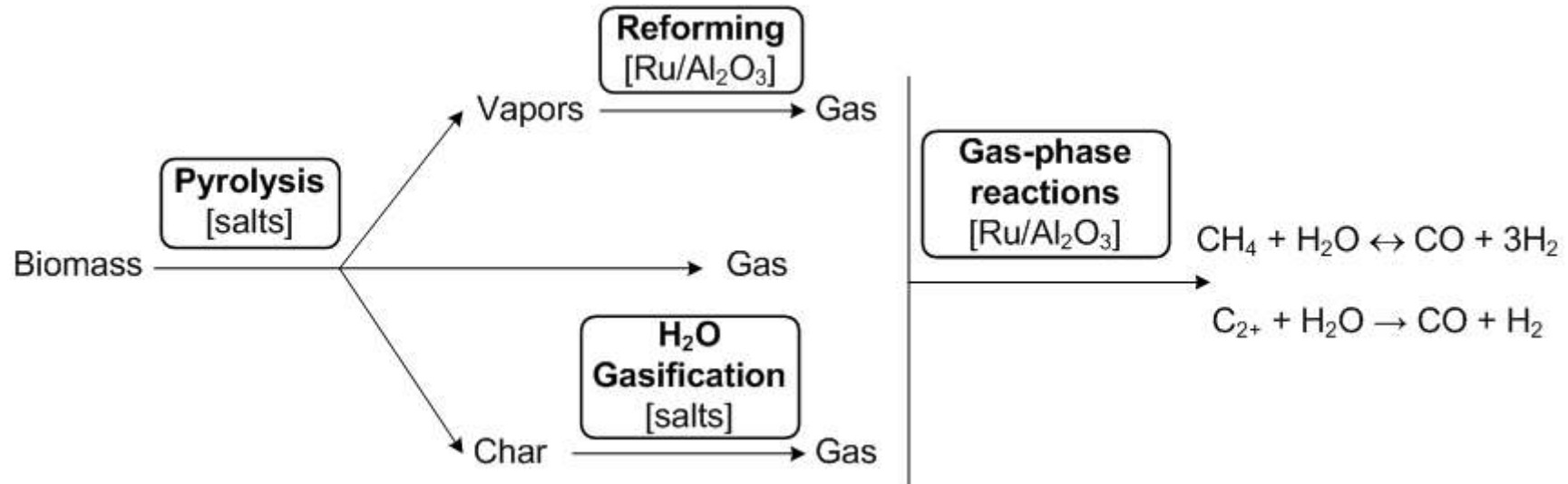
(Auto)catalytic II : Gasification



Minerals in wood (ash) catalyze the steam gasification reaction

Carbonates are considered to be the reactive intermediates

(Auto)catalytic: Mechanism

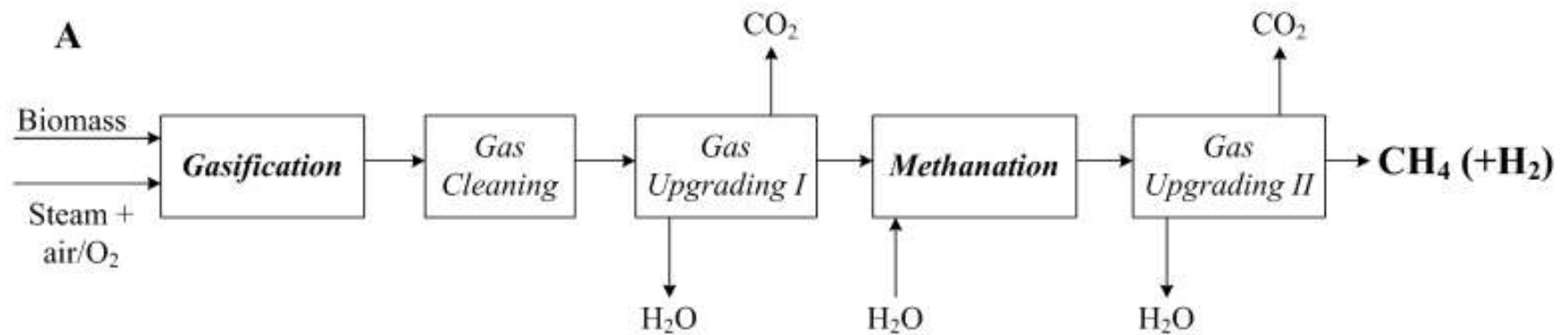


- Reforming and Gas-phase reactions are catalyzed by methanation catalysts
- Effect of salts on these reactions has still to be studied

P. Nanou, G. van Rossum, W.P.M. van Swaij, S.R.A. Kersten, Energy & Fuels, 2011, 25, 1242

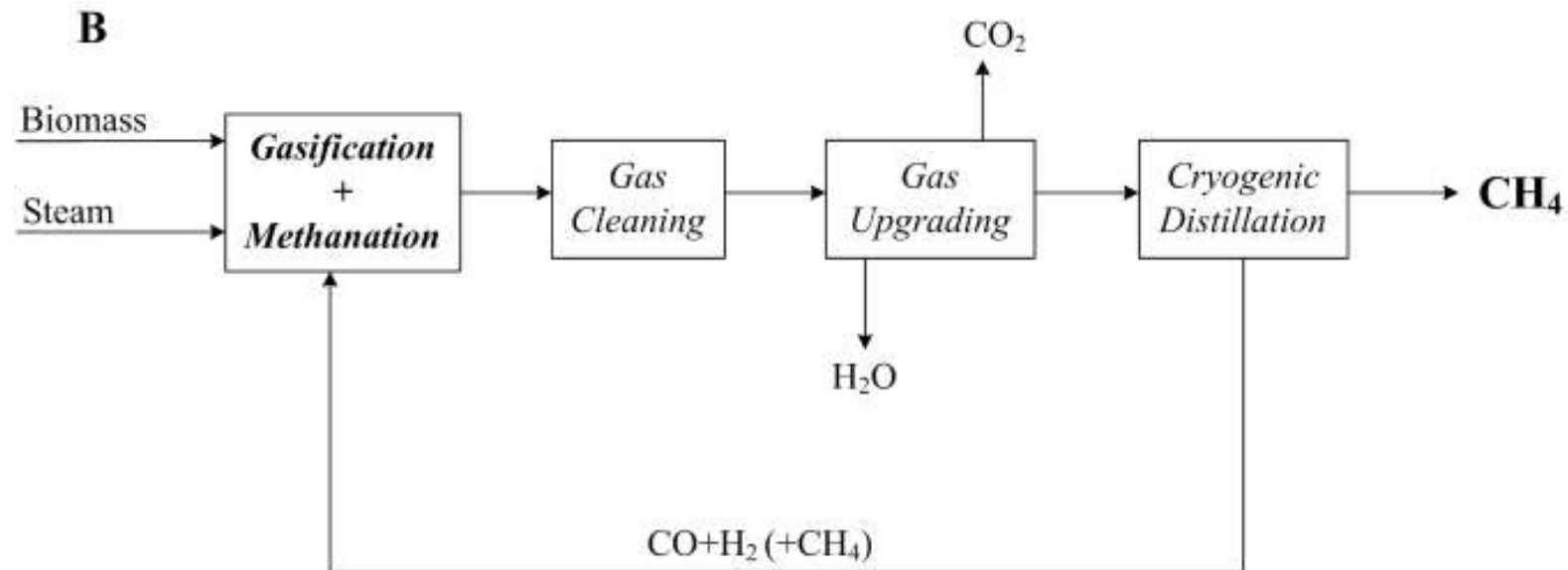
Autothermal: 3 Process Models

“Methanation” Model



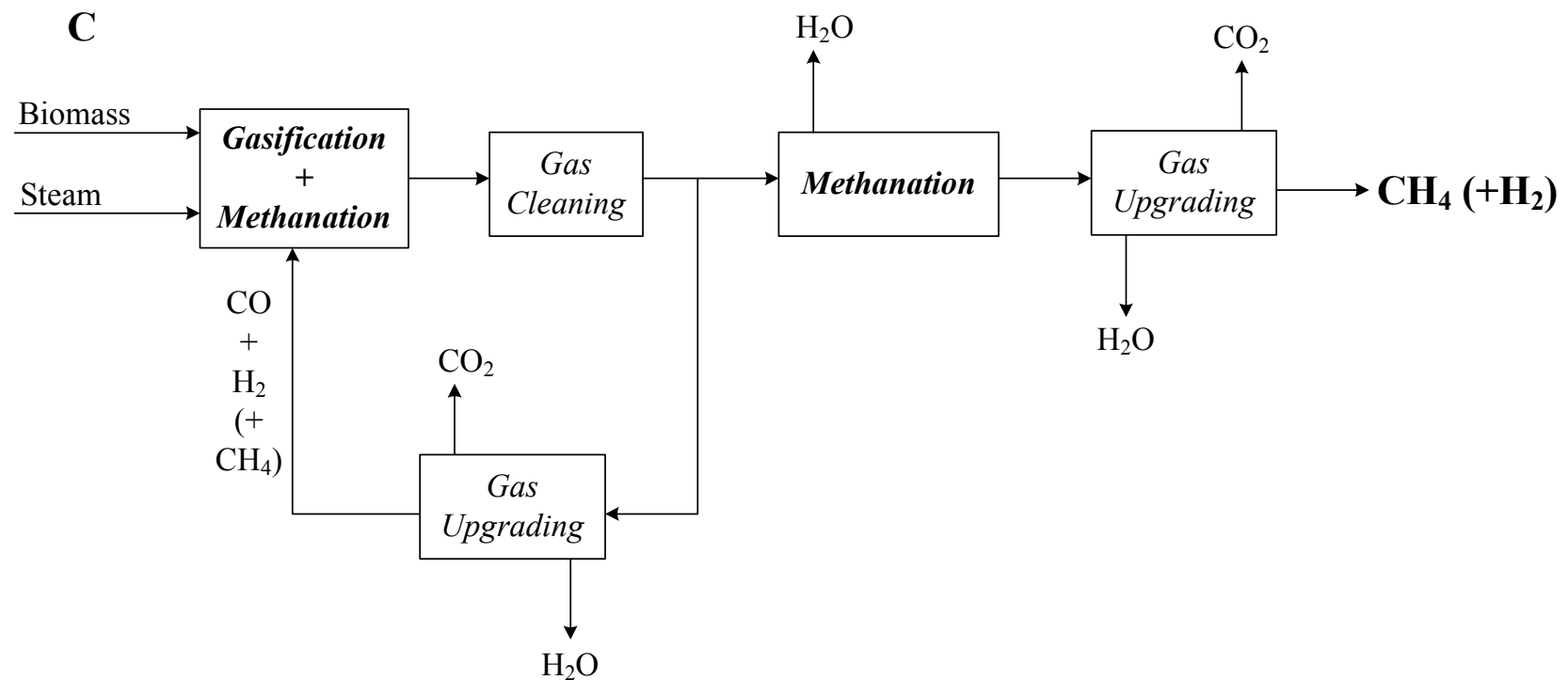
Autothermal: 3 Process Models

“Recycle” Model → Worked in the 80’s for high-pressure coal gasification (Exxon pilot)



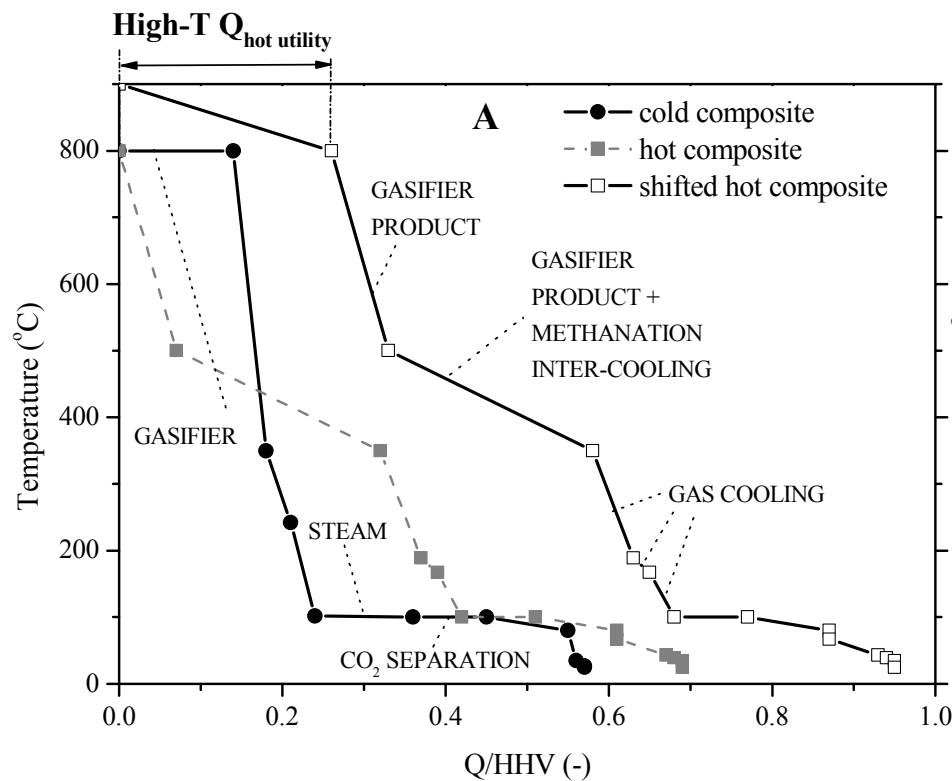
Autothermal: 3 Process Models

“Combined” Model \longrightarrow Combination of “Methanation” and “Recycle” Models

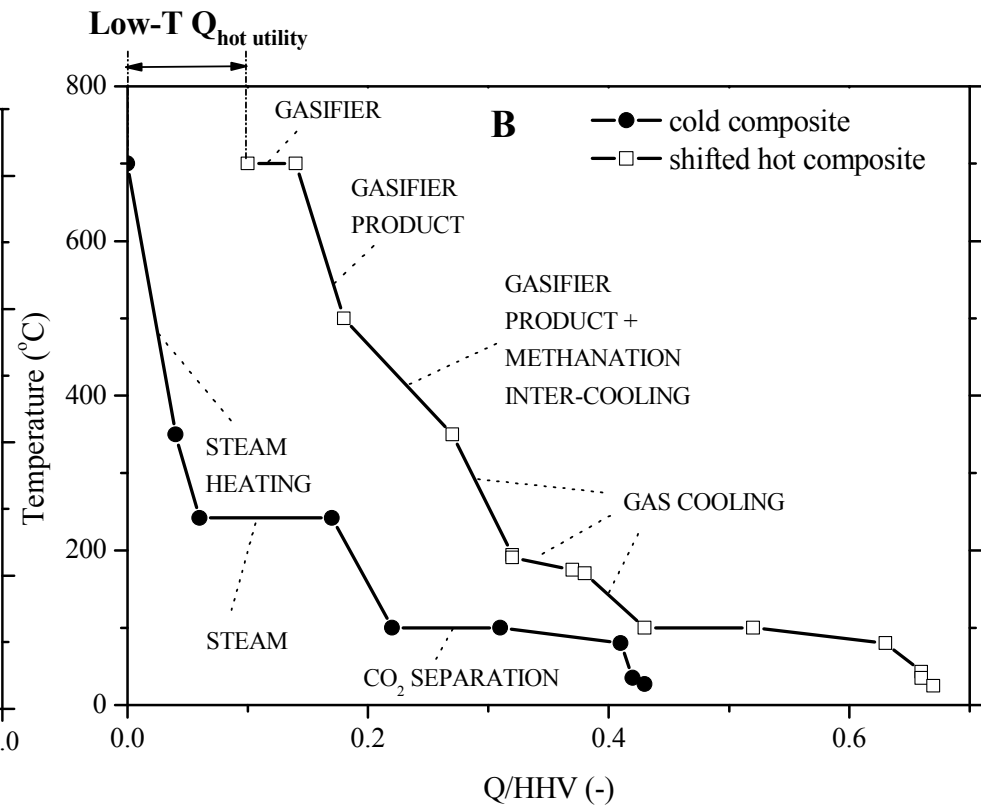


Autothermal: Heat Integration Analysis

Bottleneck: Heat demand of gasifier



Bottleneck: Heat demand of CO₂ separation unit

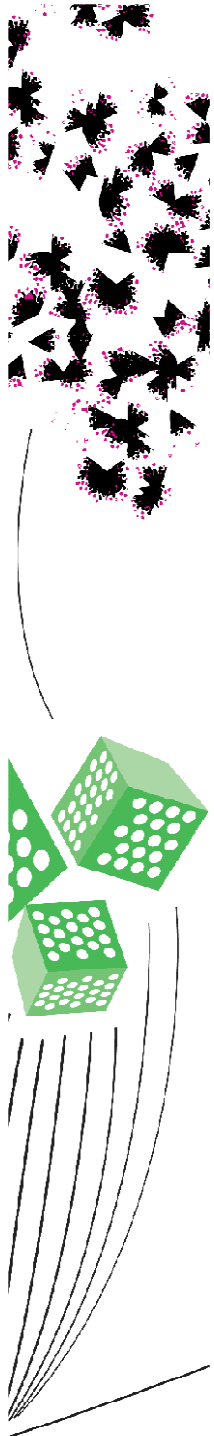


Process performance

Variables: -Gasifier operating T (700-800°C)
 -Gasifier operating P (1-35 bar)

Process	η_{CH_4} (HHV basis) Max. = 89%	Autothermal Gasifier	Autothermal Process, only if:
Methanation	49-63%	700°C (20-35 bar)	< 1 MJ/kg CO ₂
Recycle	48-58%	700°C (20-35 bar)	2 MJ/kg CO ₂
		700°C (10-15 bar) 800°C (10-35 bar)	< 1 MJ/kg CO ₂
Combined	55-66%	700°C (10-35 bar)	2 MJ/kg CO ₂

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Conclusions

- Methane can be produced via gasification and with high efficiencies (66% out of 89%)
- Low-temperature gasification is possible (700°C)
- Minerals in biomass accelerate gasification
- Autothermal gasifier is possible without use of O₂/air
- Energy requirements for the CO₂ separation unit is the bottleneck for obtaining an autothermal process
 - Improved or new CO₂ separation technology is needed (≤ 2 MJ/kg CO₂)

Thank you for your attention!

For further information:

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