Institute of Engineering Thermodynamics

Techno-economic evaluation of a new Biomass-to-Liquid process concept for reduced biofuel production cost

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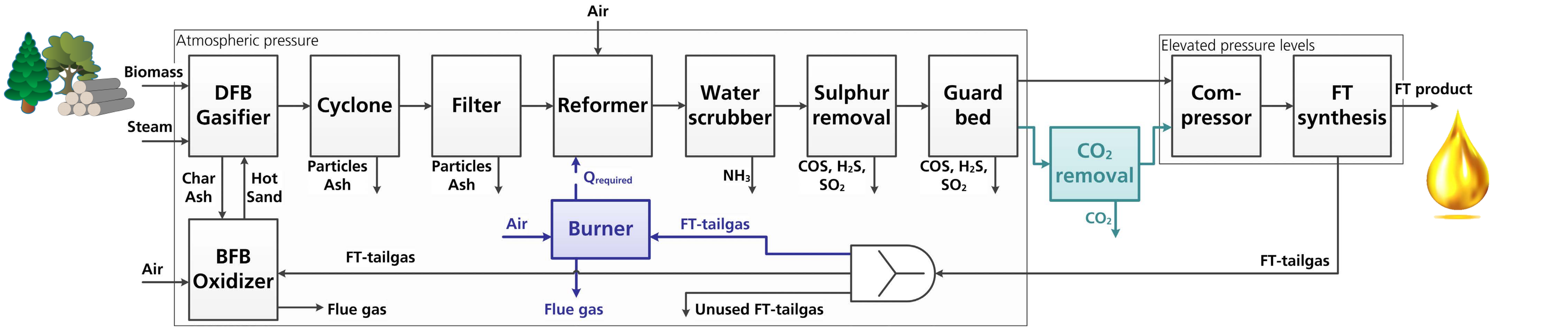
COMSYN[1] project – Motivation

- Compact and efficient process designs to enable reduced biofuels production costs via FT-synthesis
- Identification of optimal process design for maximization of energetic efficiency
- Approach: Different cases utilizing the FT-tailgas as energy provider in the gasification step
- Detailed analysis of the influence of FT performance parameters on the overall process concept

COMSYN



Analysis of three possible once-through process configurations

Case 1

- Basic project configuration
- Autothermal reforming with air

Case 2

- Autothermal reforming with air
- **CO_2 removal** after guard bed
  - Operating at 5 bar
  - 80 % CO_2 is absorbed

Case 3

- **Allothermal** reforming
  - Required heat is provided by an additional burner
  - No air is led into the reformer

Results

Results		Case 1	Case 2	Case 3
Power consumption	MW_e	8.1	7.4	7.1
FT-product	t/h	2.6	2.7	3.1
Energy flows				
Fuel	MW_{LHV}	31.9	32.6	38.3
Unused FT-tailgas	MW_{LHV}	33.3	33.6	22.2
Excess heat (> 400 °C)	MW_{th}	20.4	19.3	22.7
Efficiencies				
$BtL_{LHV\text{-}based}$	%	**30.2**	**31.2**	**36.8**
Fuel + FT-tailgas	%	62.0	63.4	58.1
incl. excess heat	%	81.4	81.9	79.9
Carbon usage	%	21.0	21.3	25.0

Basic process conditions

- Biomass input:
  - 40 t/h
  - moisture content: 50 wt.-%
  - LHV: 8.73 MJ/kg
  - → Total energy input: 97 MW
- FT operating conditions:
  - 20 bar, 240 °C
  - Chain growth rate: 0.81 (incl. adjustments for CH_4 and C_2H_6)
  - CO conversion: 74.6 %
- FT-product separation:
  - 1st stage: 20 bar, 20 °C
  - 2nd stage: 1 bar, 10 °C
- FT-product:
  - C_{5+} ($LHV_{FT\text{-}Product}$ = 44 MJ/kg)

Exemplary results: Influence of FT performance parameters

Case 1

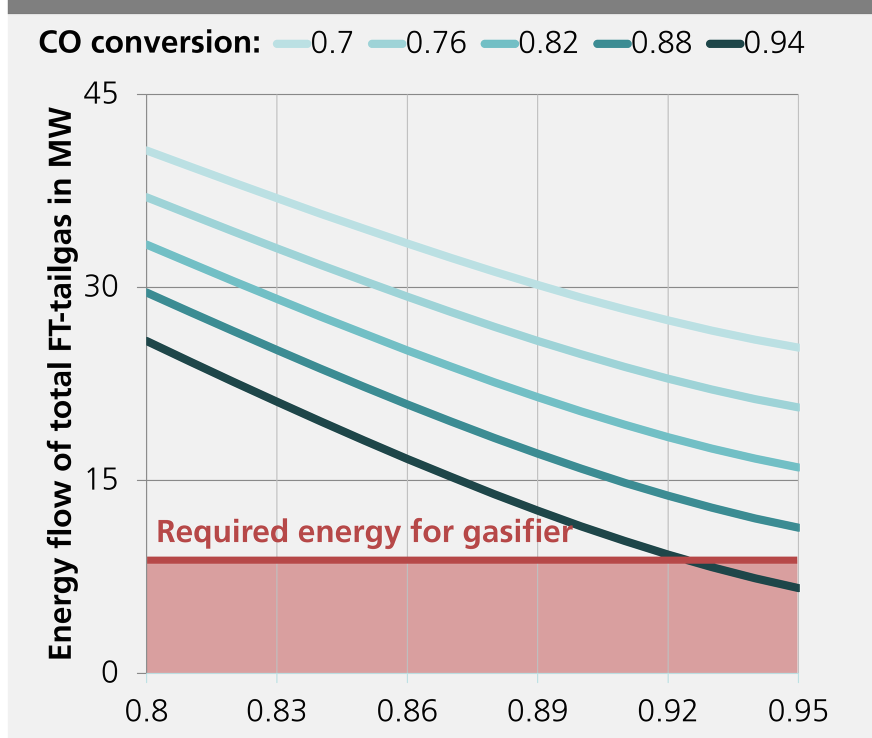


Figure 1-A

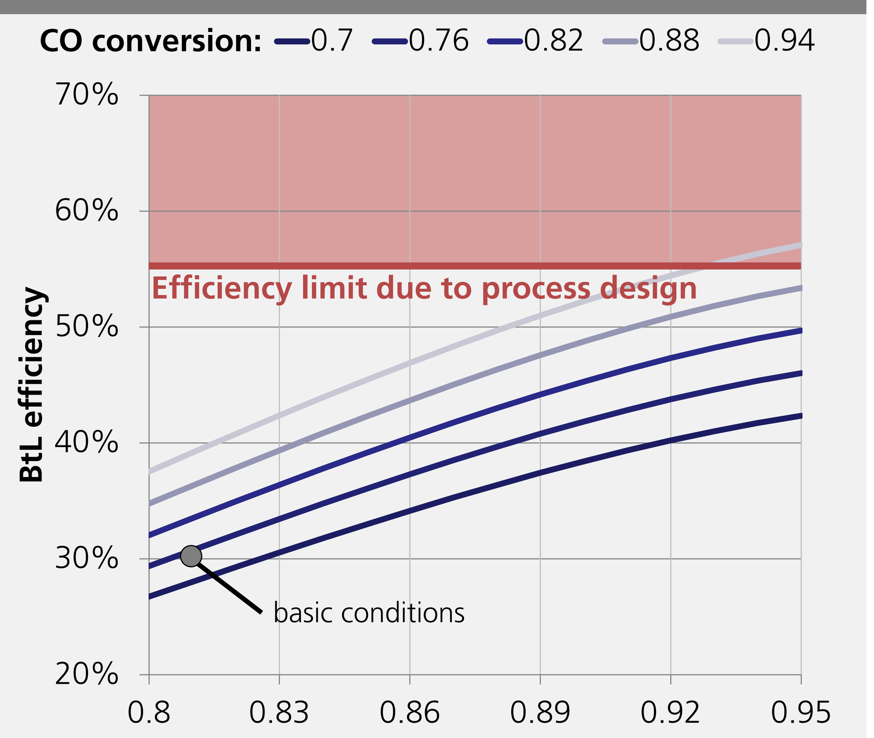


Figure 1-B

The **red** line in Figure 1-A indicates how much energy the FT-tailgas needs to contain to provide the required amount of heat in the DFB
→ Eliminating certain parameter combinations and setting a limit for the potential BtL-efficiency for each process setup (Figure 1-B, Figure 2, Figure 3)

Case 2

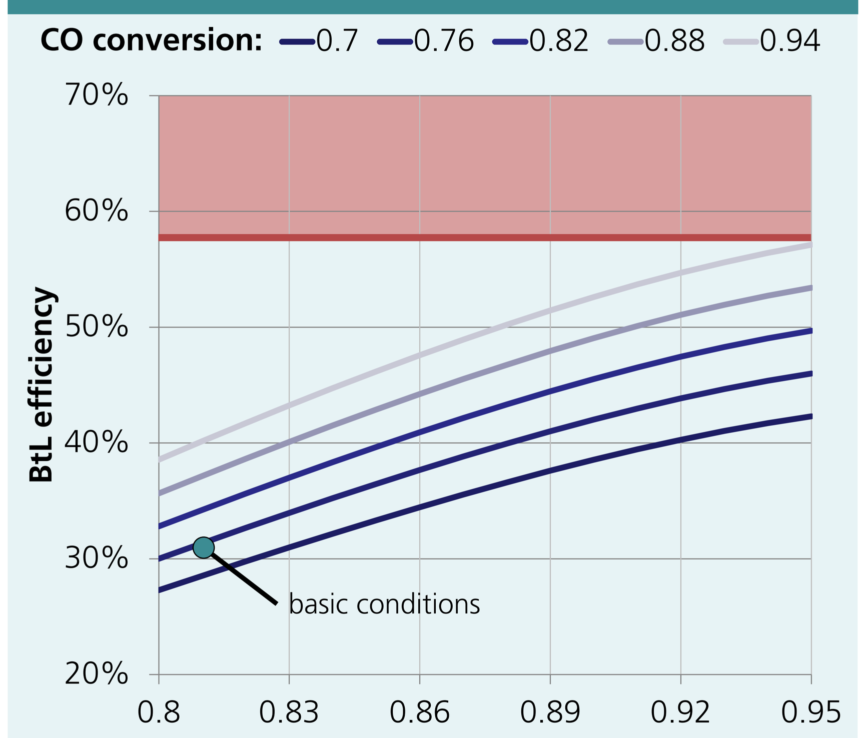


Figure 2

Lower compression work allows potentially higher BtL-efficiencies

Case 3

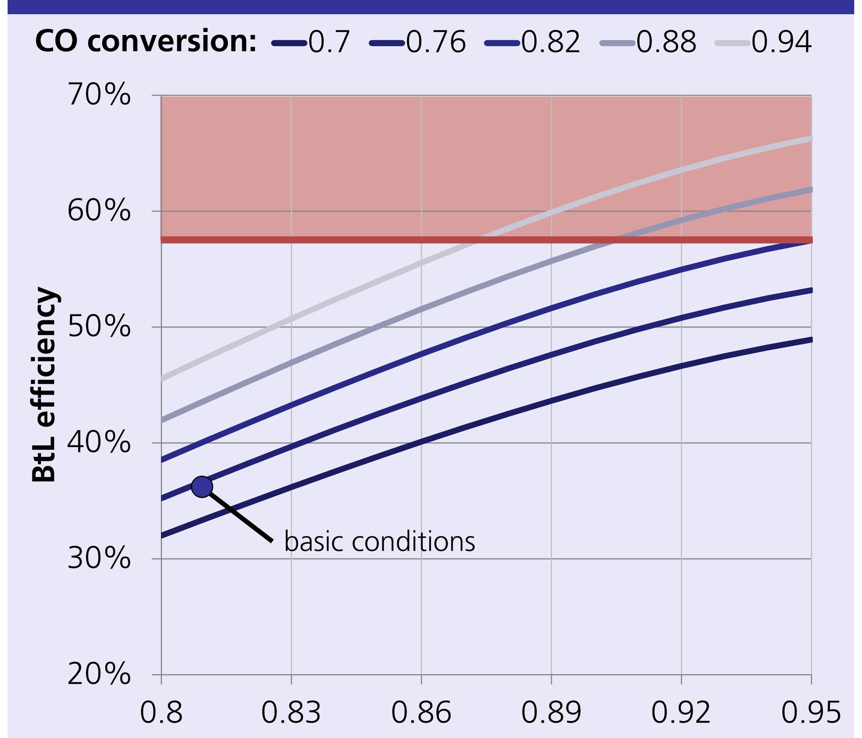


Figure 3

Allothermal reforming allows the FT synthesis to work less effective and still achieve the same maximum BtL-efficiency as case 2

Summary

- The effect of the FT performance parameters on the overall process of three different once-through process designs has been analyzed
- Decreasing the amount of inerts throughout the process allows high BtL efficiencies at moderate FT performance parameters

Outlook

- Identification of optimal process design based on experimental data and future development curves
- Detailed techno-economic evaluation and life-cycle assessment
- Implementation of fuel upgrading section
- Business cases for different countries

Acknowledgments

[1]) www.comsynproject.eu
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'An industrial approach to thermochemical biomass conversion' (Session code: ICO.8)

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