

Continuous Catalytic Hydrothermal Gasification of Synthetic Liquefied Wood at High Feed Concentrations

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INTRODUCTION



Wet biomass (liquid manure, wood, sewage sludge) contains **large energy potentials**. **USE THEM!**

Goal: Production of synthetic natural gas (SNG) as energy carrier.

Conventional, existing route:



Hydrothermal route:

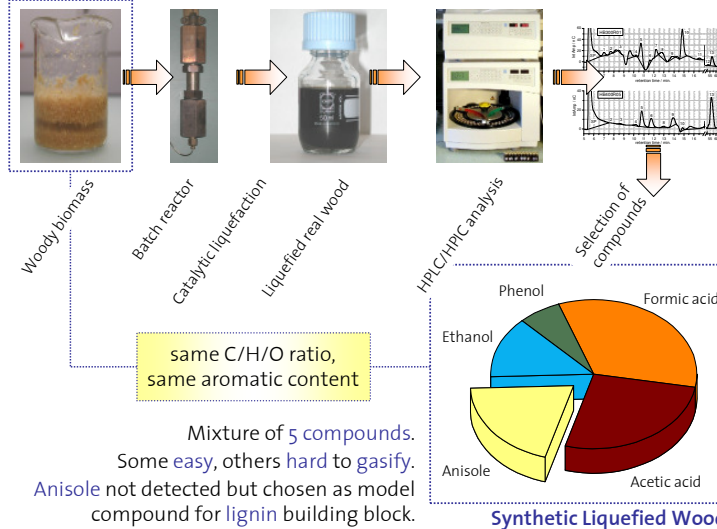


- ▶ **one step** process
- ▶ **thermal efficiency**: higher
- ▶ nutrient salts: extractable → **fertilizer**
- ▶ **no drying** → energetically less expensive

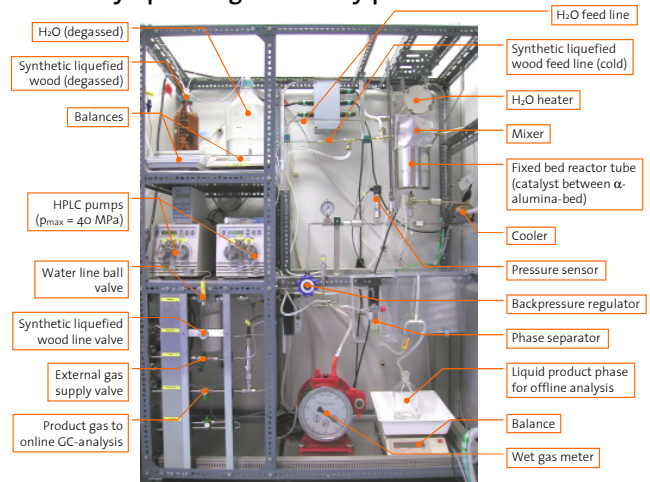
EXPERIMENTAL

Problem: Real biomass-slurry **hard to pump** on laboratory scale

Solution: identify biomass and use **synthetic liquid components**

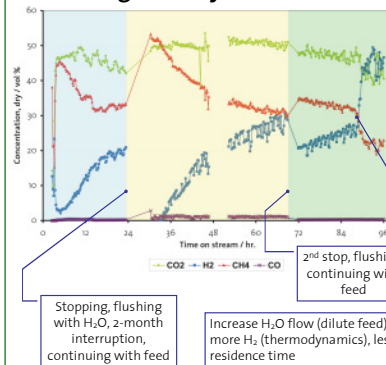


Continuously operating laboratory plant

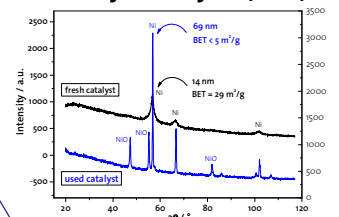


RESULTS

Online gas analysis



Catalyst analysis (XRD)



- ▶ **Chemical Ni sintering** (solvation precipitation) detected (XRD)
- ▶ **No significant accumulation of carbonaceous compounds** (XPS, TC)
- ▶ **No Ni in aqueous phase** (ICP)

Catalyst deactivation
more H₂, less CH₄, incomplete conversion of feed

- ▶ Feed concentration: 20 wt%
- ▶ WHSV = 2 g Feed / (g_{cat}·h)
- ▶ Bed temp. 400 – 420 °C, P = 30 MPa
- ▶ Catalyst = Raney Ni (stabilized)

CONCLUSIONS

- ✓ Continuous plant perfectly suited for testing catalysts under real conditions in hydrothermal environment for long times.
- ✓ High feed concentrations needed for good process efficiency.
- ✓ Synthetic liquefied wood could be completely gasified to SNG using supercritical water and Raney Ni catalyst (until deactivation).
- ✓ Catalysts must be carefully selected and tested > 100 hrs.
- ✗ Main deactivation mechanism for Raney Ni is chemical sintering. No coking / Ni leaching detected.
- ✗ Doping of Raney Ni with Ru enhances stability. Current amount insufficient. Other dopants may be better suited.

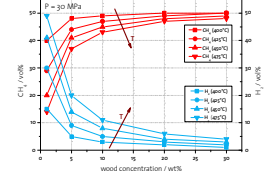
More info: Waldner, M.H.; Vogel, F., "Renewable Production of Methane from Woody Biomass by Catalytic Hydrothermal Gasification", I&ECR, 44, 13 (2005), 4543.

Why high feed concentrations?

- ▶ Thermodynamics (Target: CH₄)
- ▶ Process efficiency

Operating Conditions

- Moderate temperatures (400°C)
- High pressure (30 MPa)
- Catalyst!
- Water in supercritical state



Thermodynamic Equilibrium