Use of Life Cycle Assessment to determine the environmental impact of gasification of lignocellulosic biomass: preliminary results

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Lignocellulosic biomass

Biomass = promising energy source to replace fossil fuels.
Lignocellulose:
- Abundant in cheap and non-food materials
- Converted by second generation technologies: whole plant processed → better yield
- Less competition with food crops for land and water

Lignocellulosic biomass: a sustainable alternative? → Life Cycle Assessment (LCA) methodology to quantify its environmental impact.

Lignocellulosic biomass conversion processes

Our study

Our study

Process

Biomass pretreatment → Gasification → Gas cleaning and reforming → Gas use

Pretreatment
- Size reduction: particle size between 20 and 80 mm
- Drying: water content < 10%

Gasification

Biomass + Oxidizing agent → Syngaz

Oxidizing agent:
- Air
- Oxygen
- Steam
- Heat supply:
  - Allothermal
  - Autothermal
  - Direct or indirect

Reactors:
- Fixed-bed updraft
- Fixed-bed downdraft
- Fluidized bed

Gas cleaning and reforming

Dependent on gas use
- Particle removal: biomass (ash and char) + bed → plugging
- Alkali removal
- Nitrogen and sulfur compounds: small amount
- Tar elimination: primary (in gasifier) or secondary technologies
- Reforming: Water-shift reaction: CO + H2O ↔ CO2 + H2 → H2/CO

Conclusions and perspectives:

Lignocellulosic biomass gasification: Promising processes for substituting fossil fuels (building blocks for the chemical industry and fuels).
Their environmental impact remains uncertain → LCA methodology needed.
Numerous possibilities → sensitivity and uncertainty analysis.
Take into account the impact of biomass production.

LCA:
- Allows comparison between biomass development and fossil technologies;
- Allows a better understanding of the environmental impact of the processes;
- Takes into account several impact categories.

Bibliography


Wood gasification

Downdraft, fixed-bed two-stage gasifier X Y L O W A T T → Very low amounts of tar. This gasifier is generally considered to work close to the equilibrium state.
Small scale applications: cogeneration or used as process gas in furnaces.
Ashes end of life → Presently (Belgian legislation context): the ashes must be landfilled; in the future: field fertilization?
Co-product: system expansion by substitution (avoiding allocation procedure): the avoidance impact, from the co-product is subtracted to the system impact.
Part of a wider study: quantify the environmental impact of several uses of syngaz and comparing them with each other and more conventional fuels. Develop a better assessment of the environmental performances of currently uncommon but promising technologies → Tool to help in the decision process.