Energetic systems evaluation using Life Cycle Assessment

CHEMICAL ENGINEERING

Processes and Sustainable Development

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1. **Biomass availability**

2. Environmental evaluation of biomass utilization

3. Perspectives in biomass and bioenergy field
Type of considered biomass

- Limited to crops used for first generation biofuels
  - European energy crops
    - Wheat
    - Sugar beet
  - Non-European energy crops
    - Sugar cane
Biomass utilization

- Sugar cane
  - Transformation in bioethanol via sugars fermentation
    - Proved fuel potential
    - Chemical potential as bioethylene?

Best sustainable choice?
Biomass utilization – LCA

- Goals of study
  - To compare ethylene production from bioethanol or from fossil fuels: ‘bioethylene’ vs. ethylene
  - To allow debate on the use of bioethanol

- Functional unit
  - Production of 1 ton of bioethylene from sugarcane
Biomass utilization – Life Cycle Inventory

**Inputs**
- Raw materials
- Energy
- Water, etc.

**Inventory**
- Raw materials
  - Processing
  - Assembly
  - Transport & distribution
  - Use
  - Final disposal

**Outputs**
- Air emissions
- Water emissions
- Solid waste
- Products
- Others emissions
Steps for bioethanol production

- Cultivation of one ha
  - Tillage, fertilizers production, cultivation, harvest, etc.

- Transportation
  - From agricultural land to transformation plant

- Production of bioethanol
  - Cleaning, shredding, concentration, fermentation, pasteurization, distillation, drying of byproducts, etc.
Steps for bioethylene production

- Bioethanol production
  - All steps described before

- Dehydration of bioethanol into bioethylene

Production of fossil ethylene

- Use of database
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Biomass utilization – Impact assessment

![Graph showing impact assessment of various environmental factors for bioethane and ethene]

- Climate change
- Ozone depletion
- Human toxicity
- Photochemical oxidant formation
- Particulate matter formation
- Ionising radiation
- Terrestrial acidification
- Freshwater eutrophication
- Marine eutrophication
- Terrestrial ecotoxicity
- Freshwater ecotoxicity
- Marine ecotoxicity
- Agricultural land occupation
- Urban land occupation
- Natural land transformation
- Water depletion
- Mineral depletion
- Fossil depletion

Legend:
- Bioethane
- Ethene
Biomass utilization – Impact assessment

Impact | Unit | Bioethylene | Ethylene | Economy (Eth – Bioeth)
---|---|---|---|---
Climate change | kg CO$_2$ eq | -341 | 1463 | 1804
Fossil depletion | kg oil eq | 514 | 1623 | 1109
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Perspectives – Biomass

- Other crops to analyze
  - Sugar beet
  - Wheat

- Questions to answer
  - What is the best way of using energy crops?
  - Is it better to produce energy or chemical components?
  - How can we valorize waste?
Perspectives – Biomass

Limitation of the study

- Soil transformation (pastures or forests to arable land ➔ lost of carbon)

OR

- To find a way to evaluate this transformation and the carbon stocks
Thank you for your attention!

Any questions?