Perspective on Integrated Processing Efficiency of Biorefineries

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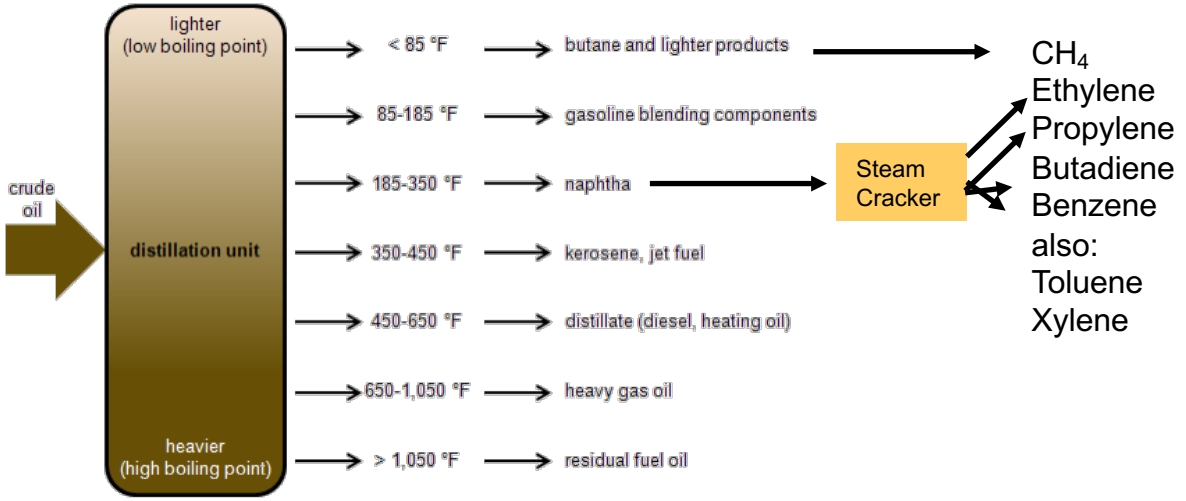
Aspect 1: Mass Flows and Concentrations

- Petrochemical synthesis
  - starts with concentrated inputs.
  - designed to achieve high product concentrations (>50%)



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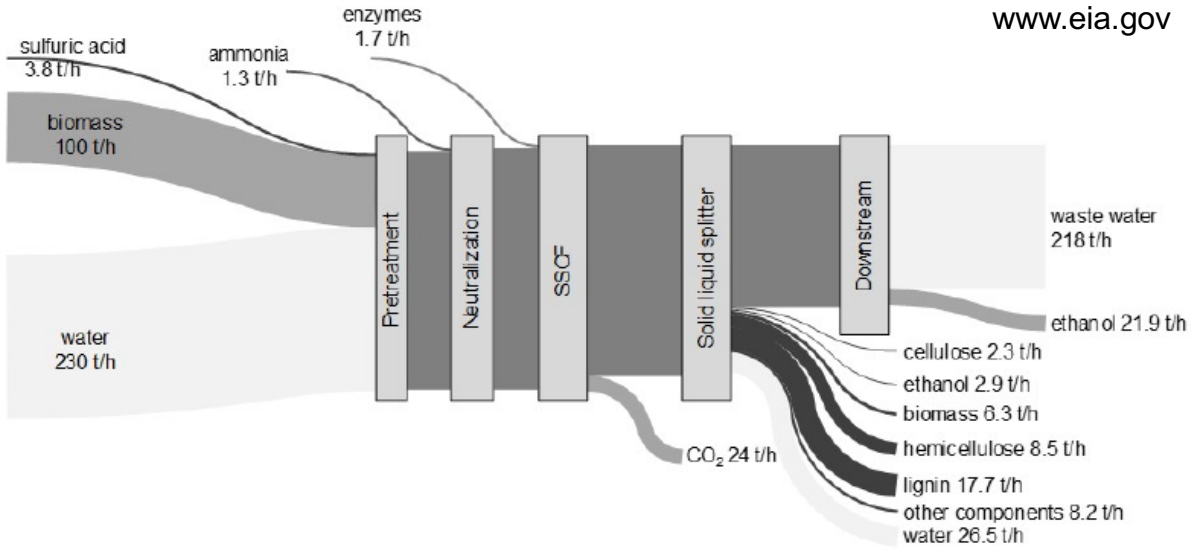
- In biorefinery processes, it is largely water with a minor fraction of product due to
  - raw material,
  - biotechnology,
  - instability of molecules.

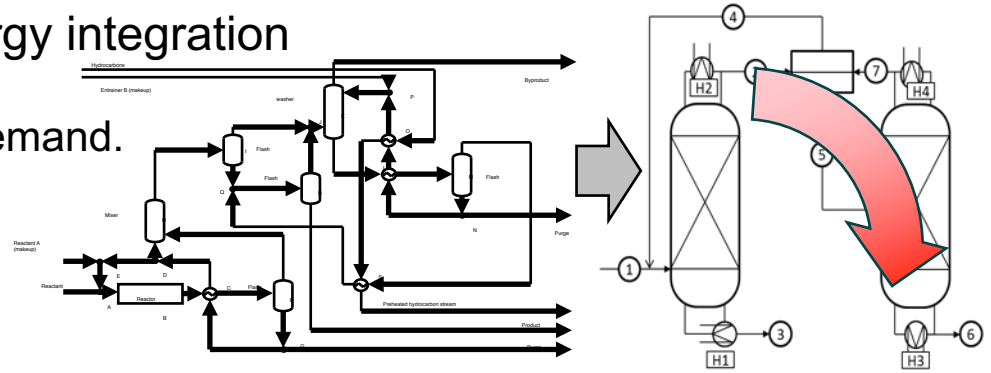


Skiborowski et al. (2018)

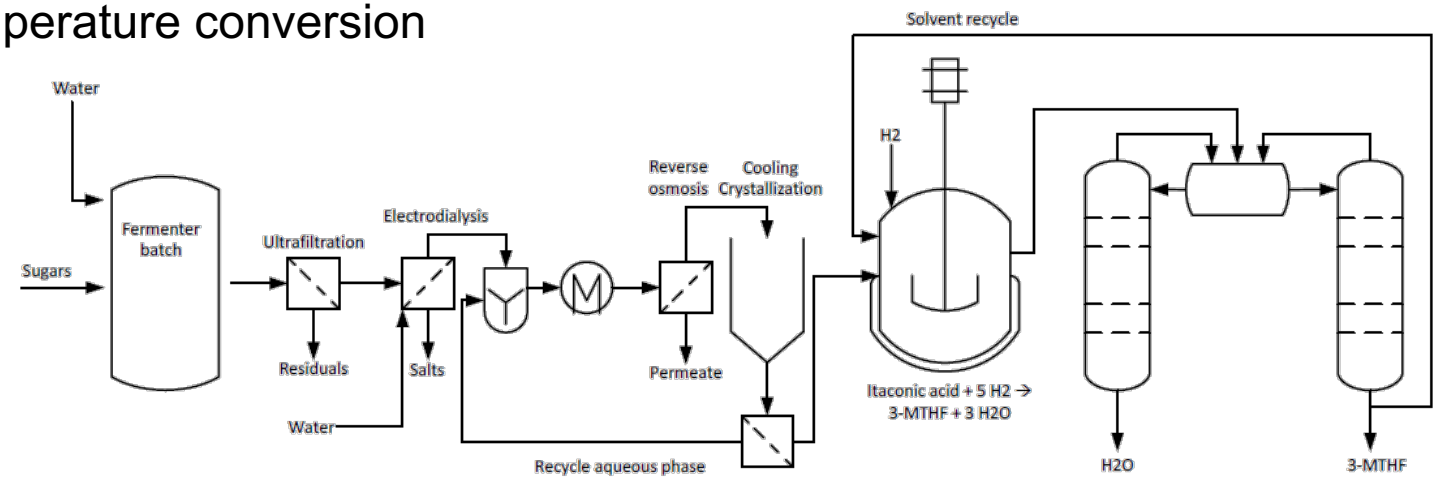
Impulse:
- novel separation technologies?
- integration in existing value chains?
- innovative wastewater treatment?

Aspect 2: Energy Integration

- Industrial processes gain energy efficiency by energy integration
  - Reactions at higher temperatures
  - saves up to 60-80% compared to the simple energy demand.



- Biotechnological processes feature low temperature conversion
  - few potential for internal energy integration



Impulse:

- other efficiency gains for biorefineries?
- integration with external energy sinks or sources?
- Do energy taxation and subsidies fit?

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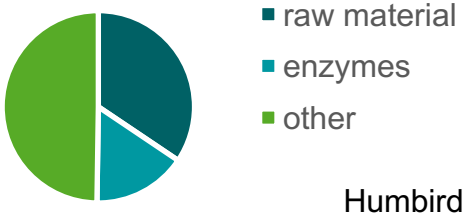
Aspect 3: Cost Structure and Economy of Scale

- Petrochemical processes: Raw materials dominate total cost.
  - high level of maturity
  - assets scale nonlinear with capacity

- Biorefineries: raw materials ≤50% of total cost
  - auxiliaries (i.e., catalysts, solvents, etc.) and investment are much more significant

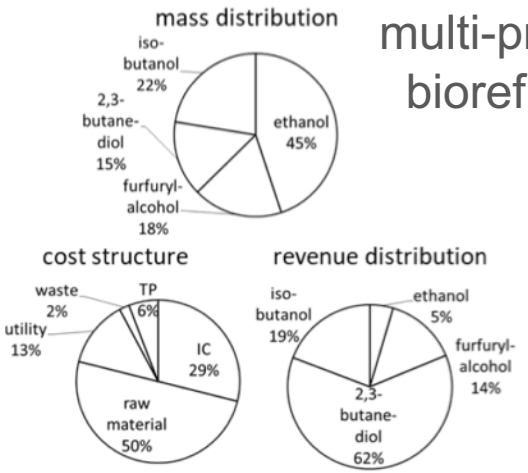
Impulse:
- integrate biorefineries in local value chains or in combined processing (sector coupling) to mitigate investment cost?
- develop more cost efficient equipment?
- foster small-scale or smart-scale processing with more favorable cost structure?

Example: bioethanol
700.000 t/a



Humbird et al. NREL (2012)

multi-product biorefinery



Skiborowski et al. (2018)

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Conclusions for Discussion

Bioeconomy is all about efficiency: mass, energy, and cost!

➡ Learn from chemical industry.

- How to bring together entities from different industries?

- Do we need to review our research strategy?

- How to enable technology for local production in view of global markets?