Conversion of CO_2 Into Linear Alkylbenzene-Based Detergents

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Goals & Motivation

Goals

- Design an industrial process converting CO_2 emissions to LAB and evaluate the economic viability and net carbon savings of the proposed process.

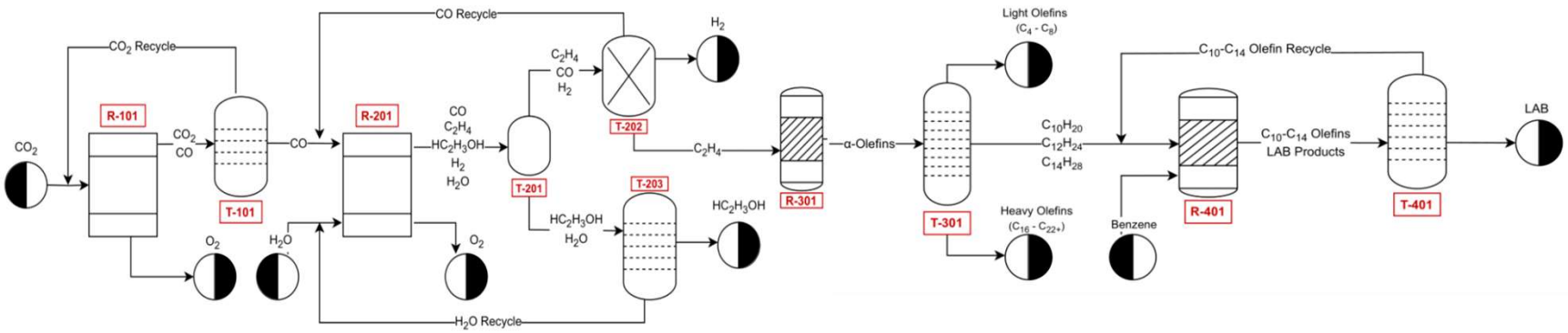
Motivation

- P&G seeks to reach net-zero greenhouse gas emissions by 2040.

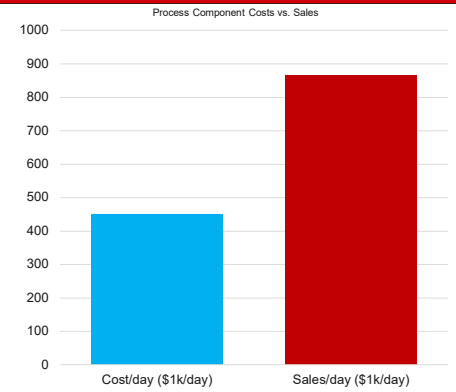
Methodology

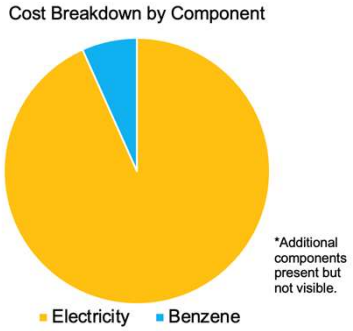
- Basis of 1000 tons CO_2 per day.
- Mass balance
  $I - O + G - C = A$
  I: Input ($\sum_i x_i \dot{m}$)
  O: Output ($\sum_j x_j \dot{m}$)
  G: Generation
  C: Consumption
  ("ξ" extent of reaction)
  A: Accumulation
  (0 at steady state)
- Energy balance
  Heating/cooling
  $\dot{Q} = \dot{m}_i C_{p,i} \Delta T$
  Perfect separation assumed
  $\dot{Q} = -\Delta \dot{G}_{mix}$
  $\dot{Q} = \dot{n} R T \sum_i x_i \ln(x_i)$
- Cradle-to-gate carbon analysis based on component carbon intensities.
- Cost and revenue per component and capital costs evaluated

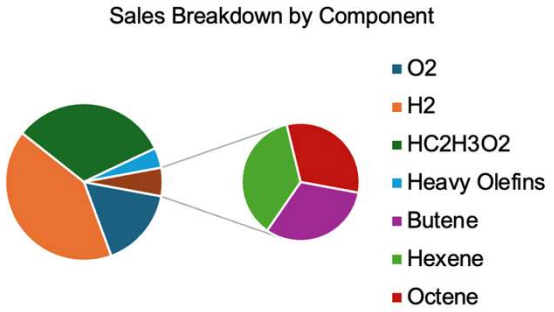
Process Flow Diagram



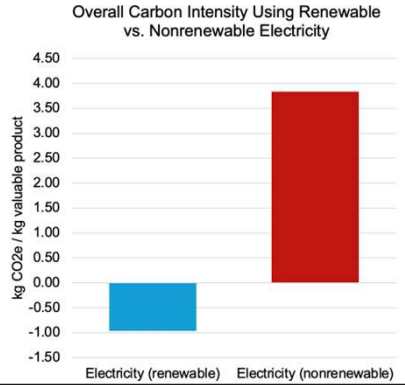
Cost Analysis

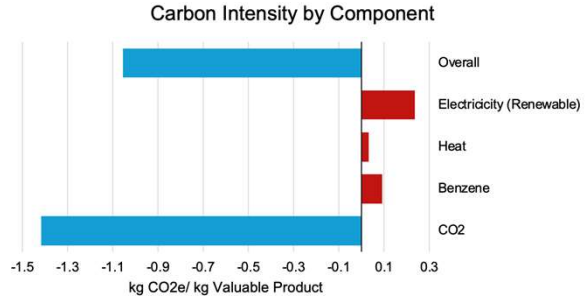






Carbon Analysis





Conclusion

- CO2-based LAB carbon savings of 1.06 kg CO_2e/kg valuable product (vs. petroleum-based LAB emissions of 2.0 kg CO_2e/kg LAB)
- Net profit of $0.53/kg product if LAB is sold at market price.
- Capital cost of equipment: $102 M.
- We recommend P&G to investigate this process further.

References

Scan this QR code to view the references used.