Depolymerization of Microbial-Derived Polyhydroxybutyrate (PHB) in an Aqueous Environment

Re-Inventing the Nation's Urban Water Infrastructure (ReNUWIt)

Morgan Sulzbach[1], Shijie Leow[2,3,4], Timothy Strathmann[3]

[1]University of Maryland, College Park , [2]University of Illinois at Urbana-Champaign, [3]Colorado School of Mines, [4]National Renewable Energy Laboratory

Introduction

Problem: Current processes to obtain PHB-rich biomass focus on high-quality plastic extraction which leads to prohibitively high costs.

Solution: An alternative approach is to accumulate PHB for carbon storage to form a biofuel from wastewater.

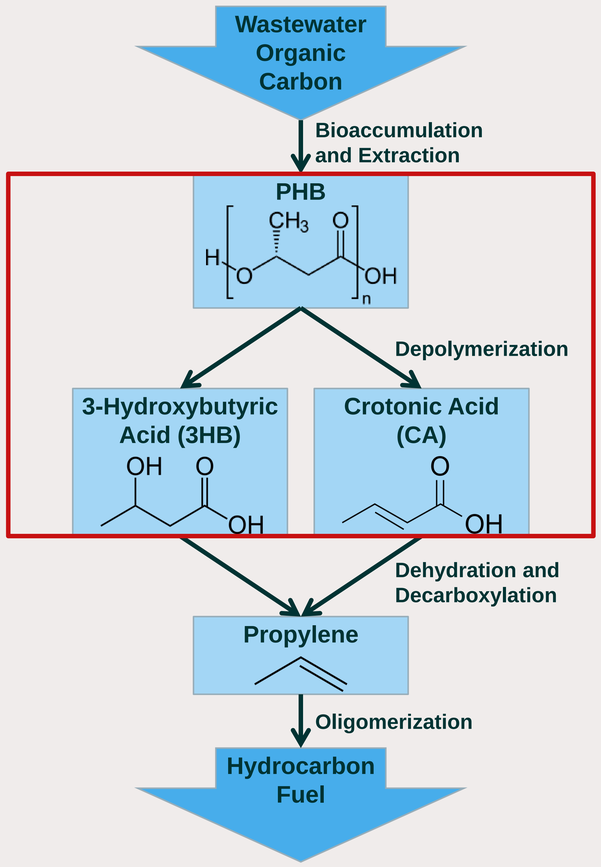

Figure 1. Overall process scheme for upgrading PHB derived from wastewater organic carbon into a hydrocarbon fuel.

Methods

Figure 2. Aqueous slurries (5 or 10 %wt PHB) were reacted in 3" steel tubes placed inside a furnace. Liquid products were analyzed using HPLC.

Results

Objective:

- Depolymerize PHB to CA and 3HB at high yields while minimizing energy demands.

Time and Loading Effects

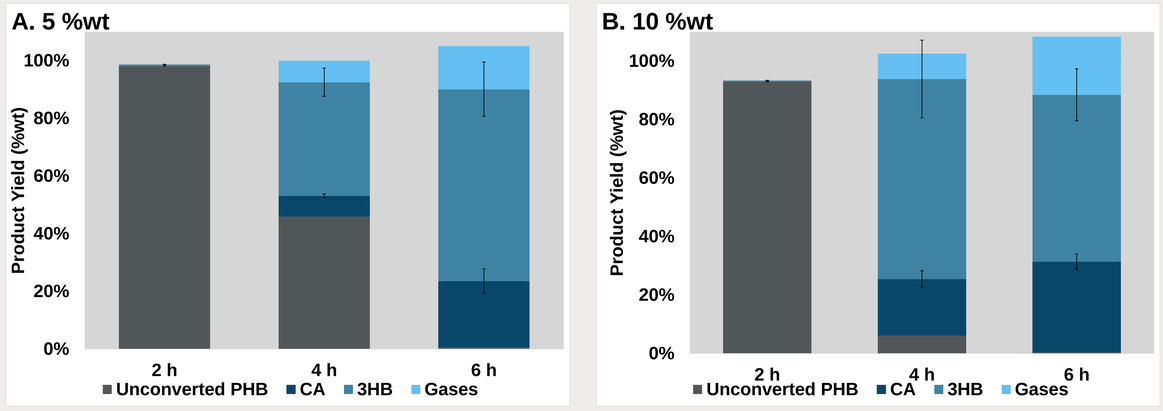

Figure 3. Product yields as a function of time at 200°C and **A.** 5 %wt and **B.** 10 %wt. Unrecovered yields were counted towards unconverted PHB.

Temperature Effect

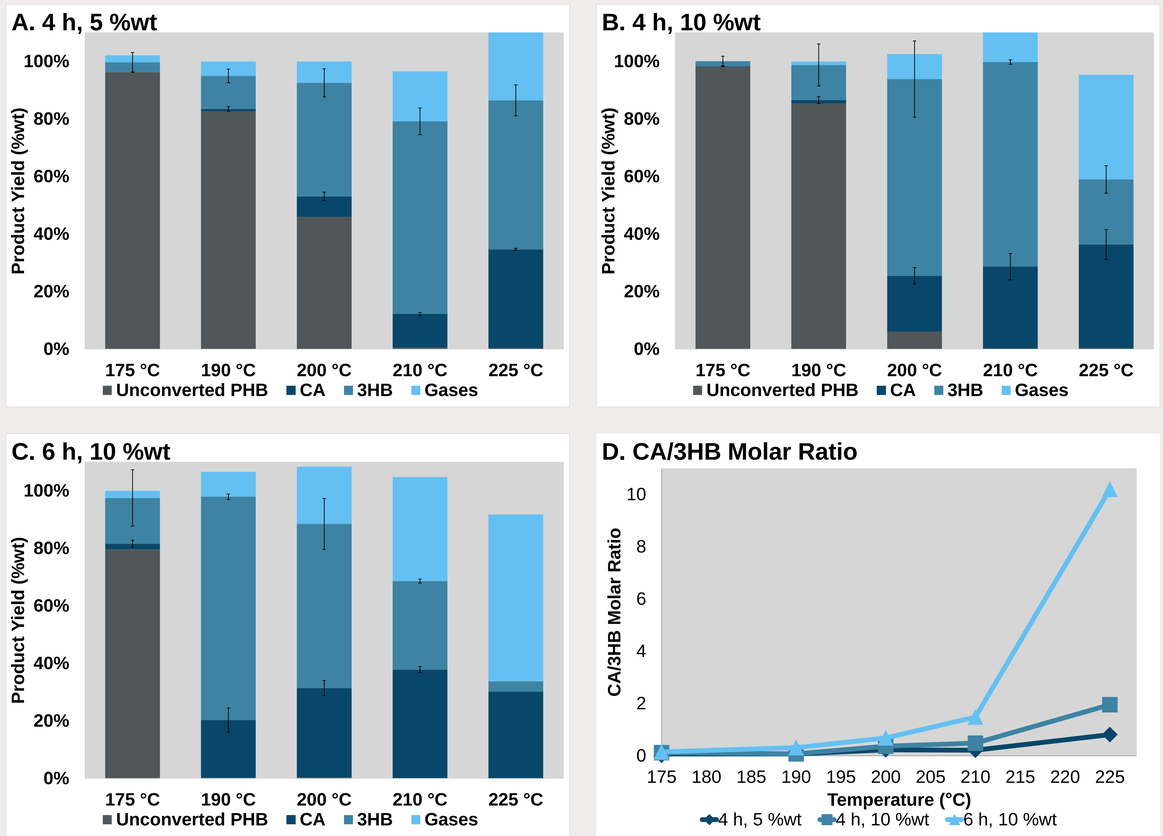

Figure 4. Product yields as a function of temperature at **A.** 4 h, 5 %wt, **B.** 4 h, 10 %wt, and **C.** 6 h, 10 %wt alongside **D.** the molar ratio of CA to 3HB. Unrecovered yields were counted towards unconverted PHB.

Observations

- Higher temperatures and longer times lead to a higher CA/3HB ratio which is hypothesized to make downstream processing easier.
- The same conditions result in more gas production; however, propylene may be one of the gases produced.

Conclusions

- PHB depolymerization in aqueous conditions and the resulting CA/3HB monomer ratio can be successfully controlled by the reaction conditions.
- Results support the final goal of having an integrated process to convert PHB to propylene all under aqueous conditions.

Future Directions

- Replicate results in a batch reactor with stirring.
- Test at lower temperatures under acidic and basic conditions.
- Optimize each step and perform life cycle analysis on the entire process.

Significance

- The process would add value to a waste stream while recycling carbon to make an energy-dense fuel.

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