TRANSITIONING TO INDUSTRY TALKS

Collaborative Research on Sustainable Aviation Fuels and Volatile Product Capture at the ABPDU

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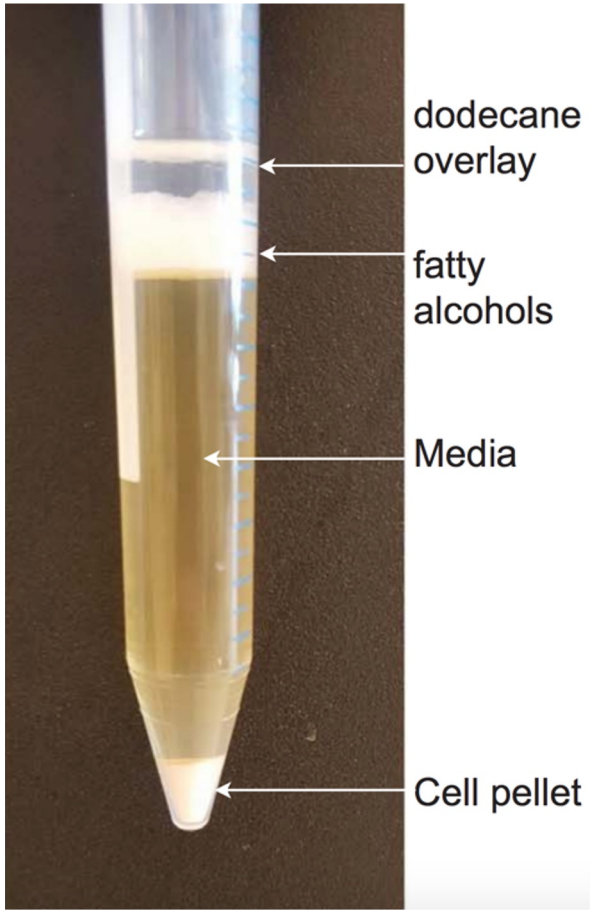
Background and Motivation
Capture of Volatile SAF and SAF Intermediates

- Production of sustainable aviation fuels is a critical BETO and DOE priority
- Separations cost is a major contributor to overall production cost
- Downstream separations for hydrophobic products are challenged by product toxicity and emulsion formation

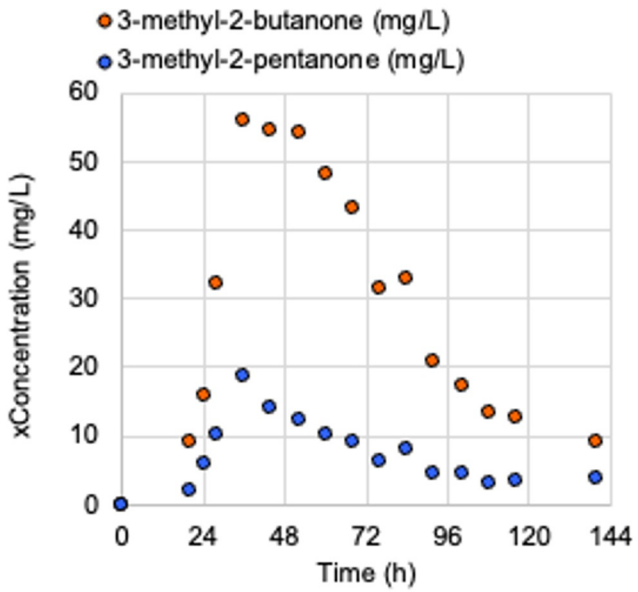


Generation of stable emulsions in extractive fermentation at ABPDU

D'espaux et al. 2017, Metabolic Engineering

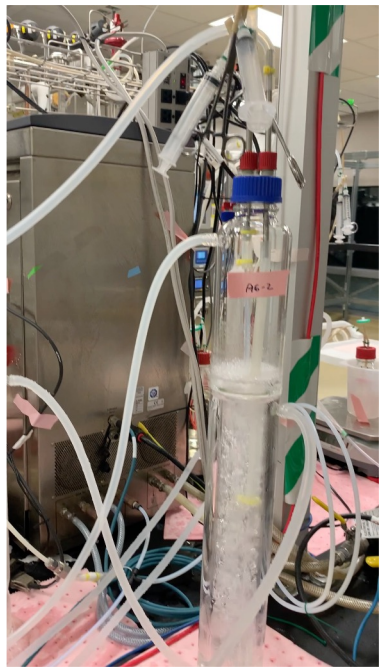
Approach
Capture of Volatile SAF and SAF Intermediates

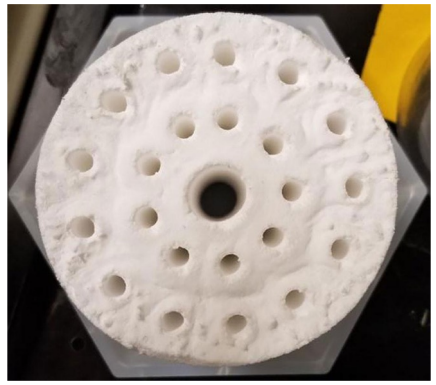
Volatile Product Capture

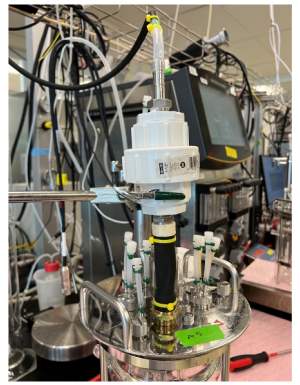


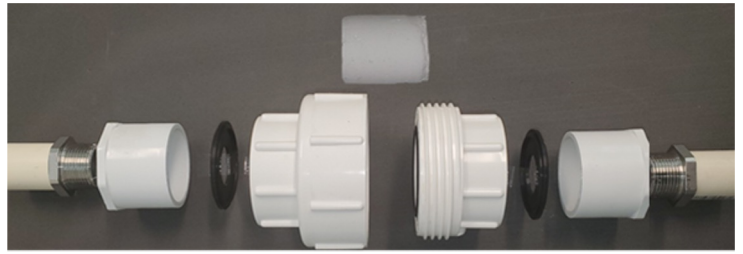
Product volatility observed at ABPDU

- SAF and SAF precursors are volatile and hydrophobic
- Partitioning to the off-gas in aerobic and gas fermentation could both alleviate separations and toxicity concerns









- Volatile product capture solutions are necessary
- Xerogel-based capture in development with ANL via the BETO Separations Consortium
- Solvent stripping deployed as baseline technology

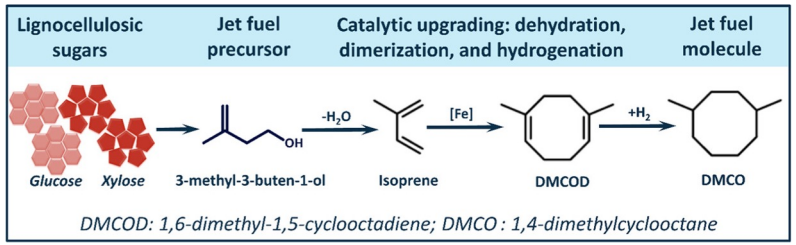
Yuzawa, Mirsiaghi et al., 2018, Nature Communications.

Progress and Outcomes

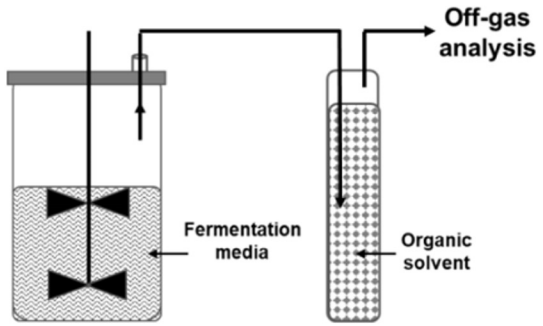
Scale-up for Production of the SAF Intermediate Isoprenol

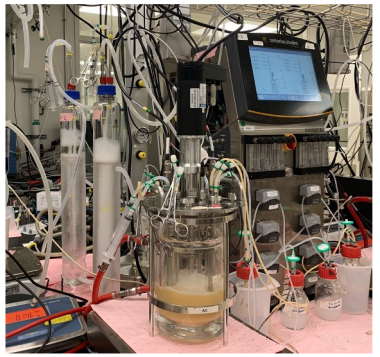
Biological Isoprenol production

- Converts to DMCO via dehydration, dimerization, and hydrotreating
- Toxic above 5 g/L aqueous concentration
- Water soluble to 140 g/L and volatile

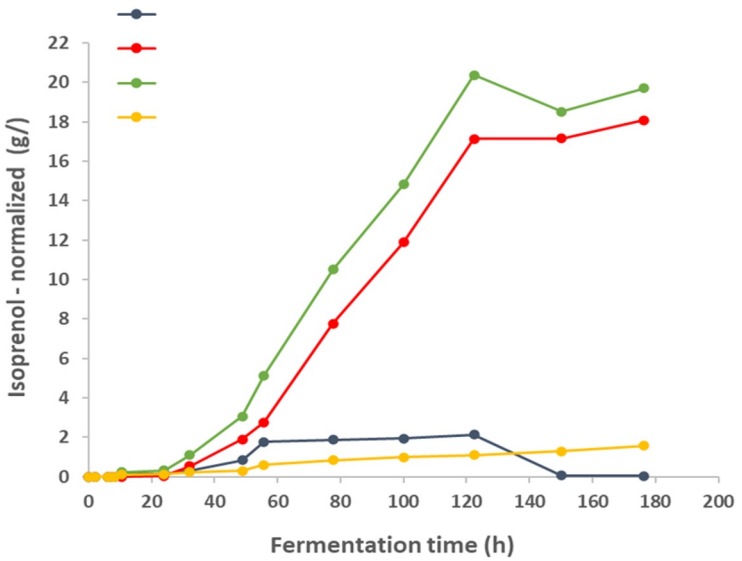


Roesenkoetter et al., Green Chem, 2019



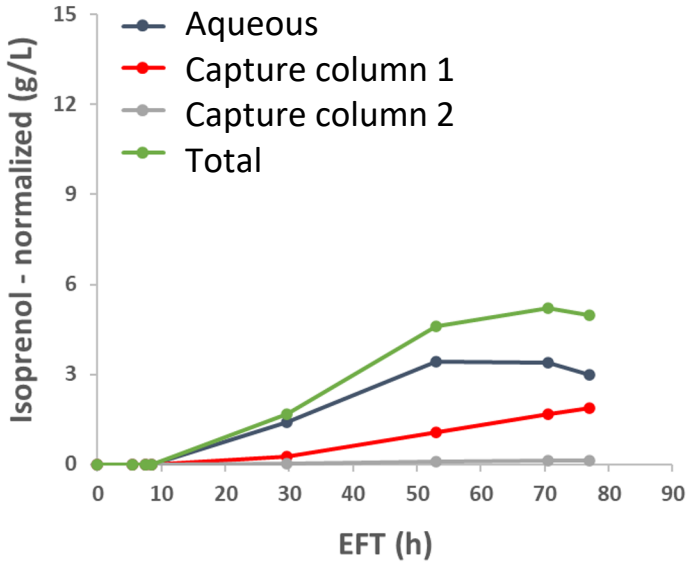


2L scale-up: Separations Consortium



At 2L scale offgas stripping can fully replace organic overlays

300L scale-up: US Navy



Scalability to 300L fermentation is challenged by back pressure and reduced aeration rates – toxicity limits titers

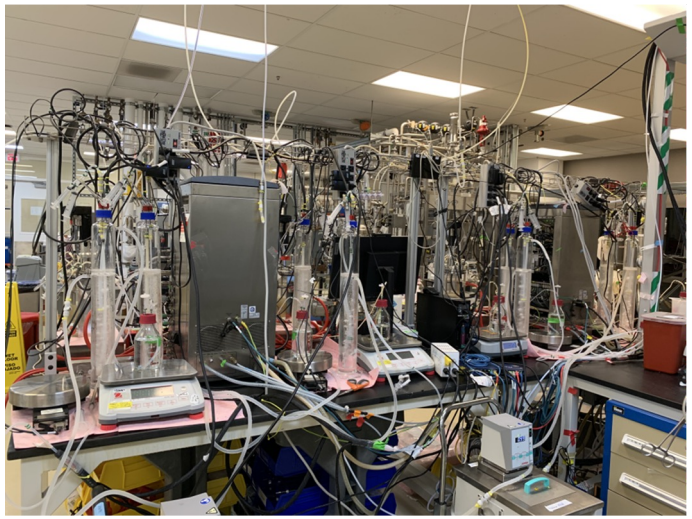
Progress and Outcomes
Off-gas Capture of Isoprenyl Acetate

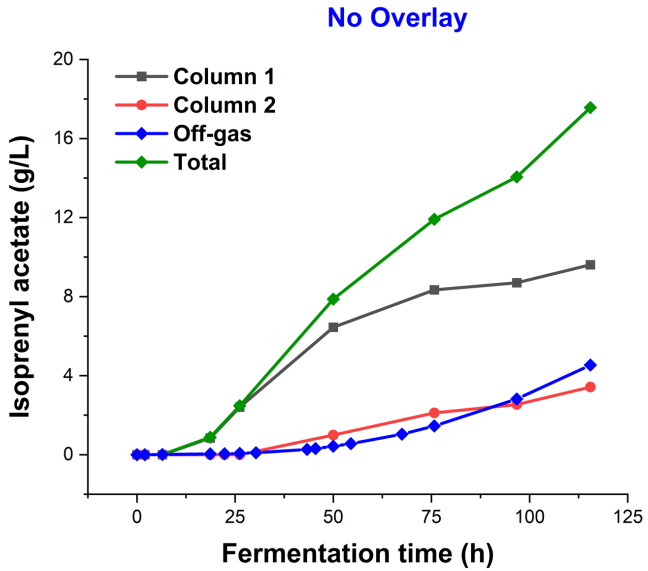
Co-Optimization of Fuels & Engines

Isoprenyl acetate (IPA) production
- Esterification improves both hydrophobicity and volatility vs isoprenol
- Toxicity challenges mitigated
- Cleaves readily to isoprenol and acetate

Carruthers et al, Biotech for Biofuels, 2023

Off-gas capture
- Demonstrated titers of 18 g/L without overlay at 2L scale – well above 2.5 g/L toxicity threshold
- Currently assessing scalability to 300 L
- *Preferred scale-up alternative*





AB PDU

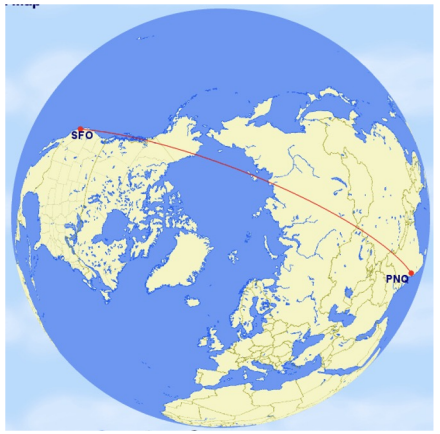
BIOPROCESSING SEPARATIONS CONSORTIUM

Impact

Scale-up and Deployment for SAF Production with Industry Collaborators

TCF project with Praj Industries

- Generation of 2,000 gallons DMCO for a business jet test flight
- Tech transfer completed within 10% of ABPDU process spec
- Integrated piloting in progress for deployment at 30,000 L scale



Off-gas capture with Amyris

- 300 L offgas capture campaigns at ABPDU for volatile terpene capture
- Production of high energy density jet fuel for fuel properties evaluation


Bioenergy Technologies Office

ABPDU's Gas Capture Capability Enables Production of Sustainable Aviation Fuel Molecule

FEBRUARY 6, 2023

Bioenergy Technologies Office » ABPDU's Gas Capture Capability Enables Production of Sustainable Aviation Fuel Molecule

Author: Katy Christiansen, Laboratory Relationship Manager, Lawrence Berkeley National Laboratory

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ABPDU, the Bioprocessing Separations Consortium, ANL, and Amyris have joined forces to meet the growing demand for sustainable aviation fuels using gas capture technologies. Photo courtesy of Unsplash.com

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TECHNOLOGY COMMERCIALIZATION FUND

TRANSITIONING TO INDUSTRY TALKS

Collaborative Research on Feedstock Variability and Blending at the ABPDU

James Gardner, ABPDU

Karen Warner, CEO and Founder, BEAM Circular

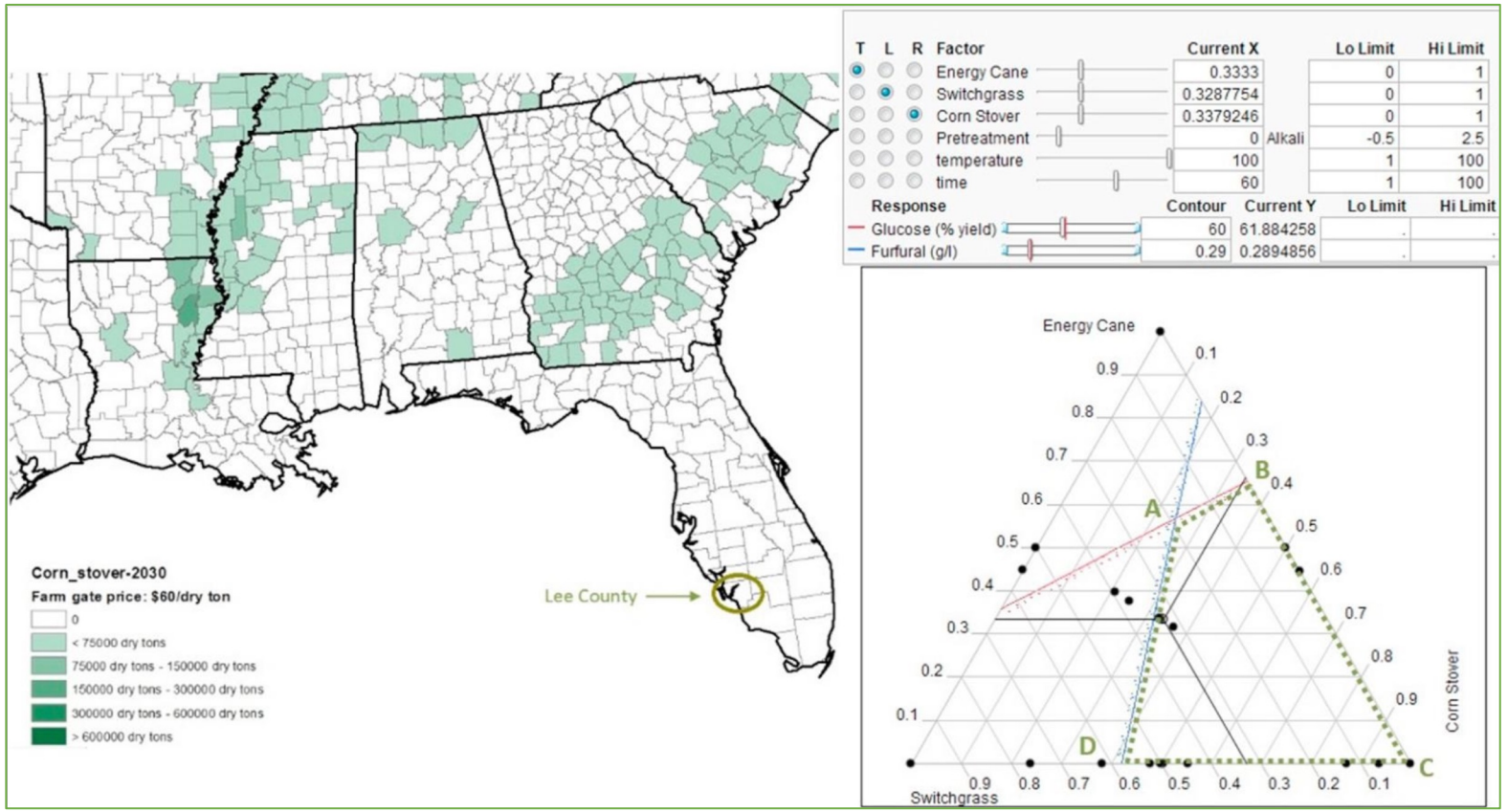
Feedstock Diversity and Blending

Feedstock blending is a de-risking strategy, to overcome yield limitations from more recalcitrant agricultural residues. *doi.org/10.1016/j.biortech.2017.06.156*

TEA also pointed to possible advantages of blending, for theoretical biorefineries situated in regions of the US (e.g., Florida) without ready access to monocultural ag residues. *doi.org/10.1016/j.biortech.2018.09.103*

Owing to the high crop diversity of California's agricultural heartland, regional biorefineries could stand to benefit from blending strategies, as an approach to improving process economics.

Impact: This research supported a successful application for a $1M NSF planning grant, related to the North San Joaquin Valley **Bioindustrial Manufacturing Innovation Engine**.



FCIC Task 7 Low Temperature Conversion

- Over 2 dozen **critical material attributes** (CMAs) can influence growth and product titer for SAF precursor production in strains of the oleaginous yeast, *Rhodosporidium toruloides*.

- Proteomics experimentation, in coordination with Agile BioFoundry researchers, revealed protective mechanisms for elimination of **metal ion contaminants** and correlated with **lower growth and product titer** and **high iron in hydrolysates**.

- Studies of moisture content, ash content, drought conditions, and corn stover anatomical fractions revealed that various strains and species differ in their levels of sensitivity to material and process attributes.

- **Impact:** This research is contributing to the body of knowledge which growers and biorefinery operators will be able to use for feedstock evaluation as a function of critical attributes. Manuscripts in preparation and in press .

North San Joaquin Valley Bioindustrial Manufacturing Innovation Engine

- **North San Joaquin Valley (NSJV) opportunities**
  Home to some of the most productive farming in the US
  Vast agricultural residue-based feedstocks and an ag/food processing workforce with relevant skills
  Counties are investing in bioindustrial manufacturing at demonstration and commercial scales.

- **ABPDU is contributing to the discussion among other thought leaders and stakeholders.**
  UC Merced investigators and support teams from the Brookings Institute was recently awarded a $1M planning grant. A successful outcome could lead to a phase 2 $160M NSF grant to establish a bioindustrial manufacturing innovation engine that will serve the region and bolster US Biomanufacturing.

- **Impact**
  Stanislaus County recently announced its investment of $10M as a seed for this effort.
  ABPDU will continue its support of the work and establish a consulting relationship, to help pursue grants and philanthropic funding opportunities and set the stage for growth of the US bioeconomy.