A MICROSCALE-BASED DEVICE FOR THE PROCESS INTENSIFICATION OF ALCOHOL EXTRACTION AND PHASE SEPARATION

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Objectives and project statement

- Feed stream 20% Isopropyl alcohol (IPA) in water
- Recover IPA through phase separation
- Compare conventional LLE to MMS LLE economics using best-case solvent
- Recycle solvent through solvent recovery

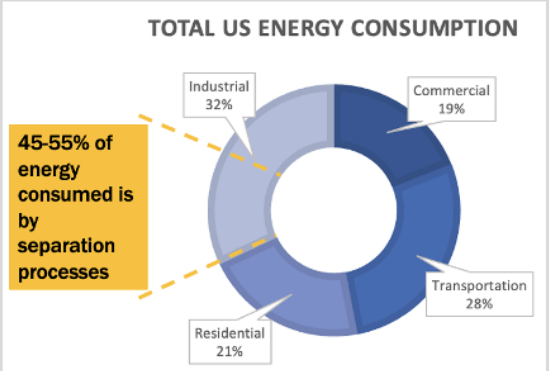

Figure 3 – US energy consumption by category[1]

Value Statement

- Separation processes account for 45-555% of US energy consumption (Figure 3)
- MMS based separation require little to no energy consumption
- Significant opportunity to reduce CO_2 emissions

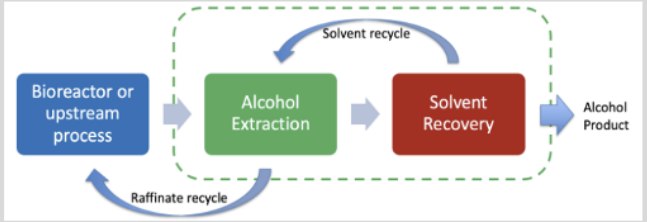

Figure 1 – Project flow diagram

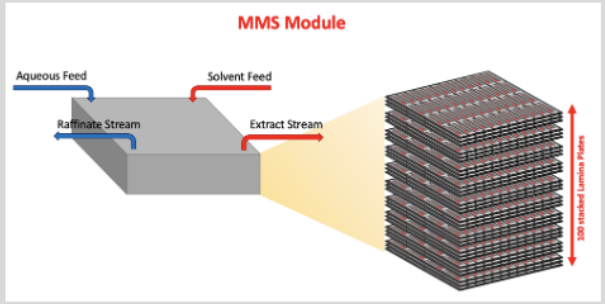

Figure 2 – MMS module scaling up capabilities

What is Multiphase-Microscale Separation (MMS)?

- Utilizes interfacial surface tension through capillary pressure gradients to achieve separation compared to traditional buoyancy driven LLE columns
- Device is a small flat plat (Figure 4) that can be scaled up (Figure 2) to meet demand

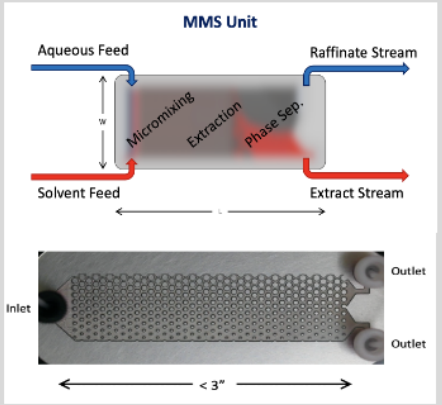

Figure 4 – MMS LLE unit: processes and size

Preliminary Design Results

	Product IPA Weight Percent	IPA Recovery Percent	Product IPA/Solvent Molar Flow Ratio	Water Molar Flow in IPA Product (kmol/hr)
MMS LLE	80.42%	98.62%	23.10	1.40
Conventional LLE	81.54%	96.53%	129.27	2.12

Future work

- Economic analysis
  - Comparing CapEx and OpEx of conventional to MMS LLE
- Ionic liquids as entrainer
  - Greener chemistry
  - Tunable properties
- Reducing solvent cost
  - Utilizing smaller O:A flow ratio to achieve optimal product specs

Citations: [1] *Murnen, H. (2016). Separation processes with hope for purification energy efficiency. Retrieved May 20, 2021, from https://chemical-materials.elsevier.com/chemical-manufacturing-excellence/separation-processes-for-energy-efficiency/*

Zoeblin, Connor M., 2017, *Design of a Microstructure Liquid-Liquid Separator Utilizing a Capillary Pressure Gradient, 2021*