TEAM M026

The Recovery of the Palm waste components to produce green energy and sustainable materials via HMF conversion and electrolysis

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Introduction

- Palm waste is abundant yet underutilized, offering a major opportunity for conversion into valuable chemicals and clean energy
- A two-stage process converts palm biomass first into HMF, then electrochemically oxidized to FDCA — a petroleum-free plastic alternative — while co-producing hydrogen gas
- An integrated, multidisciplinary bench-scale platform combines chemical, electrical, mechanical, materials, and computer engineering into one continuous, automated system

Problem Statement

- A compact, modular system that converts palm agricultural waste into FDCA and hydrogen, turning a local waste stream into valuable products while reducing waste-related emissions and supporting cleaner materials and energy production.

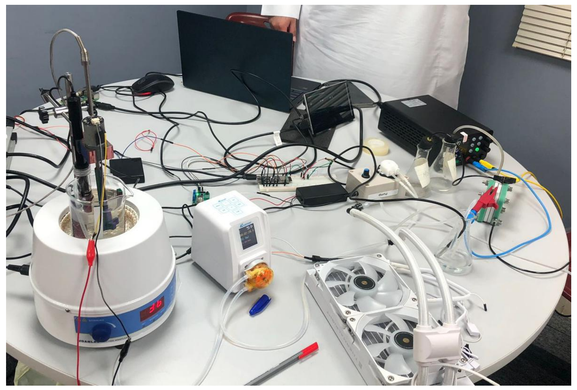
Specifications

- Fructose/Glucose efficiency ≥ 45%.
- Energy output ≥ 0.4 MJ/kg.
- HMF purity through HPLC >50%.
- ML error rate ≤ 10%.
- Cooling unit reduces ΔT by ≥1 °C.
- Four baffles improve mixing, raising initial HMF formation by ≥1%.
- Sensor readings are logged and visualized with rate ≤ 1 sample/min.
- ESP32 reads stable sensor data.
- Must exceed 80% crystalline CoOOH.
- CoOOH ECSA must exceed 9*10^4 cm².
- Supply the electrolyzer with regulated 0–2.7 V DC.
- Auto shutdown within 5 sec.
- Total power less than 2000 W
- Continues operation in steady state system

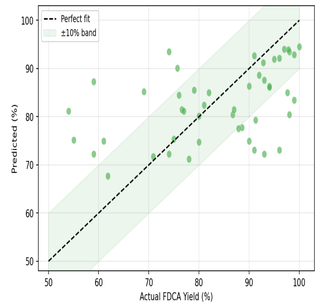
Constraints

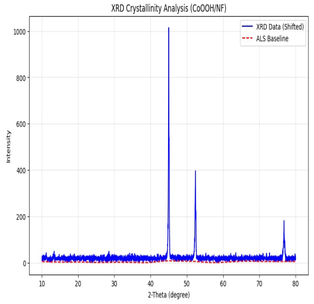
- Max 2 products from HMF oxidation
- Use corrosion-resistant, cost-effective materials
- ESP32 should not exceed its maximum RAM
- Normal power remains ≤ 2500W
- Must resist pH 14 KOH
- Thermal resistance for the reactor

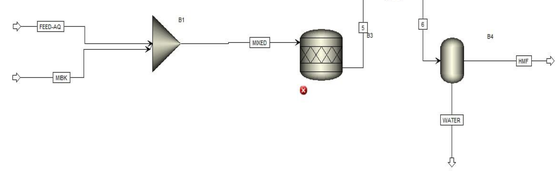
Prototype Design



Testing/Validation







Conclusion

- Smart, compact platform converts fructose → HMF → FDCA + H_2 via electrocatalysis.
- Fructose feed is used to improve HMF yield control and reduce variability.
- CoOOH/Nickel Foam catalyst selected for high selectivity and alkaline durability.
- ESP32 + Raspberry Pi enable real-time monitoring, safety shutdown & ML yield prediction.
- Multidisciplinary design emphasizing operability, data integrity, and safety.