

Meet my Lab x JFS

Clean, Accessible and Secure Energy Supply

Wednesday, 20 March 2024

9:00-10:45am CET / 15:00 - 16:45 Jakarta



HANIFRAHMAWAN SUDIBYO, PH.D

ASSISTANT PROFESSOR OF CHEMICAL ENGINEERING DEPARTMENT, UNIVERSITAS GADJAH MADA

RESEARCH FOCUS:

SYSTEMS APPROACH FOR SUSTAINABLE BIOMASS WASTE MANAGEMENT

A collaboration between



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SYSTEMS APPROACH FOR SUSTAINABLE BIOMASS WASTE MANAGEMENT

Bioresource Engineering
and
Biomaterial Lab

Chemical Engineering Department
Universitas Gadjah Mada

2024



IChemE

Our Team



Wiratni Budhijanto, Ph.D.

Mesophilic and thermophilic
anaerobic digestion
Biosynthesis of chemicals and
materials



Lisendra Marbelia, Ph.D.

Membrane technology
Bioprocess engineering
Wastewater treatment



Hanifrahmawan Sudiby, Ph.D.

Subcritical and supercritical fluid technology
Hydrothermal liquefaction
Aqueous-phase reforming
Thermochemical synthesis of organics

Our Team



Daniel Tanto

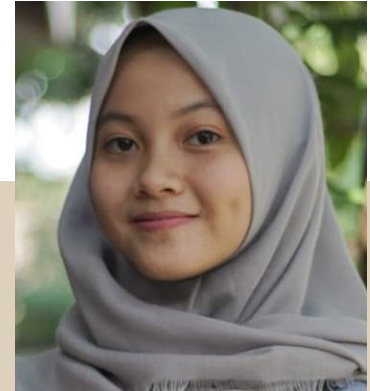
Machinery construction
Equipment power systems
High-pressure equipment welding



Rifki Wahyu Kurnianto

PhD candidate in Sanitary Engineering
from TU Delft

Biological treatment of wastewater
Fermentative biorefinery



Aqiela Mahannada

Will continue M.Sc. at
Imperial College London in the Fall of 2024

CO₂ utilization via electrochemical reduction
into methane

Outline

- Previous Works
 - Ongoing Project
 - Future Research & Potential Collaborator
 - How to Reach Us
-



Circular Bioeconomy

Integrated Biorefineries

Integrated biorefineries consist of a combination of bio- and thermo-chemical unit processes that aim to transform biomass waste via multiple conversion pathways into high value-added products

Waste Hierarchy

Prevention, reuses, recycling, recovery, and disposal

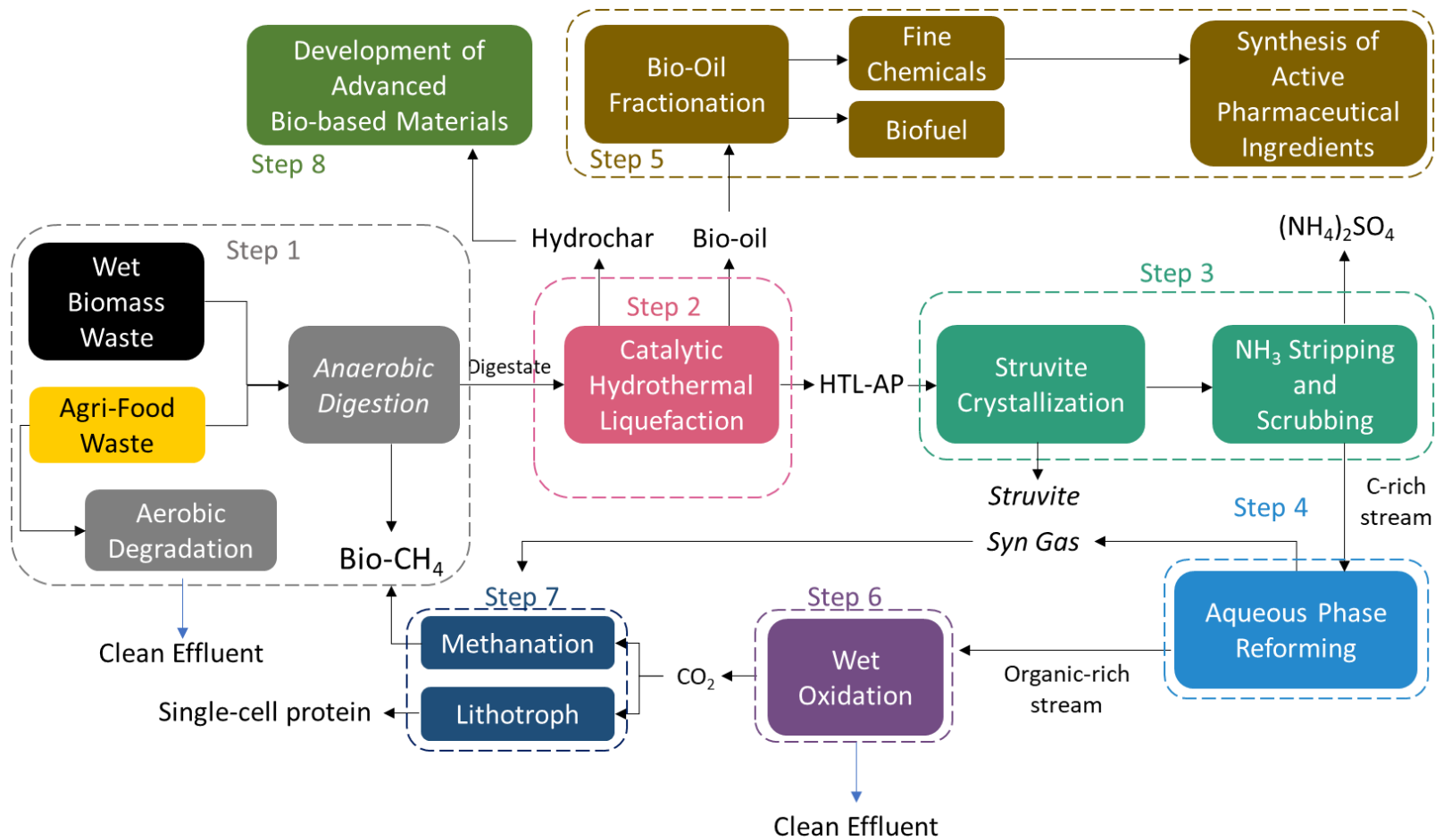
Biobased Economy Value Pyramid

From top to bottom: pharmaceutical and fine chemicals, food and feed, functional and commodity chemicals, and energy, heat, and fuel

Significances for Sustainability

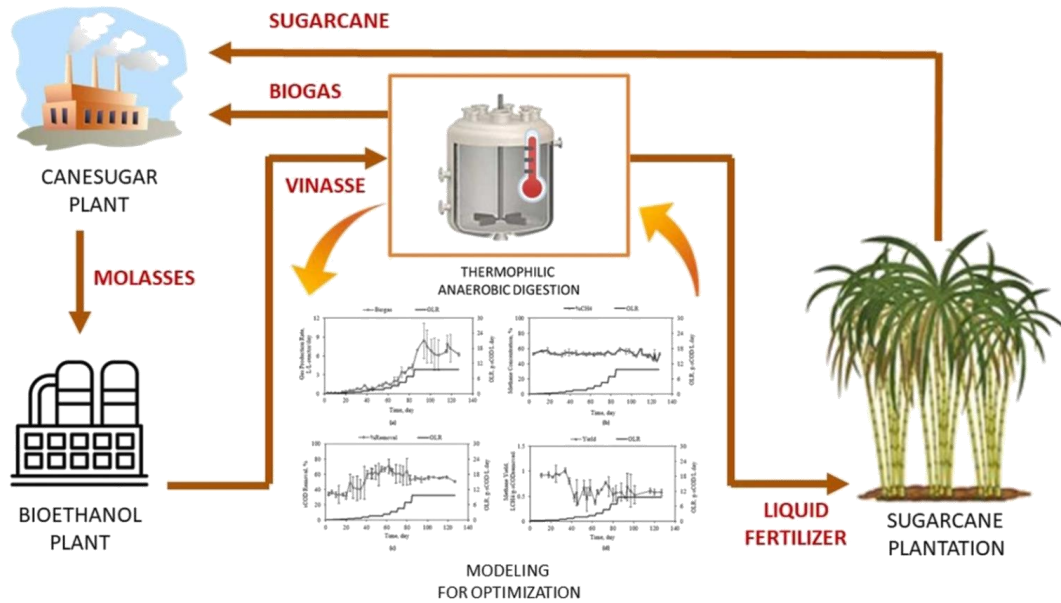
Extending the life cycle of materials, establishing the closed loops of materials and commodities, and conserving natural resources in sustainable manner

Our Proposed Biorefineries



PREVIOUS WORKS





Integrating thermophilic AD into the bio-EtOH plant

Thermophilic AD Kinetic

We investigated the kinetics of thermophilic anaerobic digestion of sugarcane vinasse inoculated with acclimated digested cow manure

Bioreactor Performance Prediction

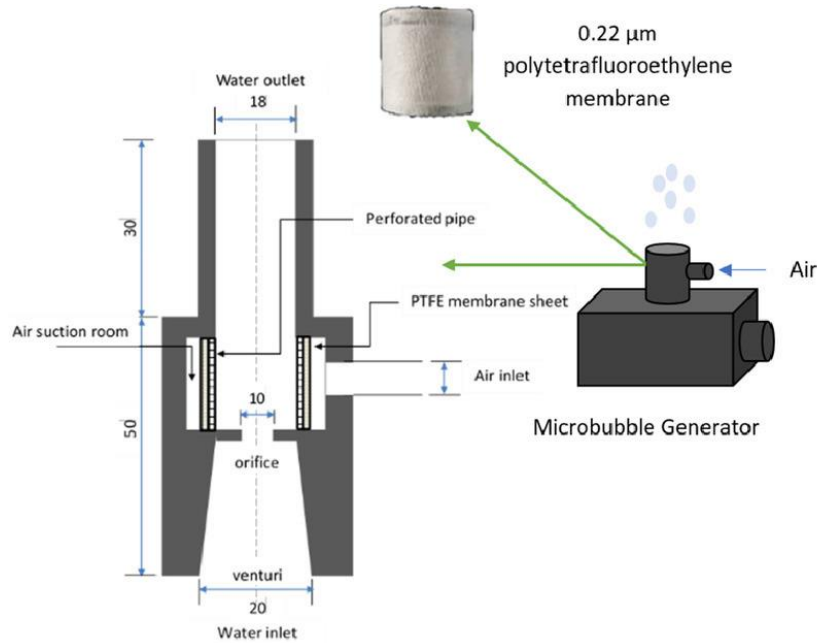
We used experimentally-informed ADM1 model of AQUASIM in predicting the behavior of thermophilic AD of sugarcane vinasse in a CSTR with microbial immobilization media.



Techno-economic evaluation

We evaluated the techno-economic performance of two types of thermophilic anaerobic reactors and three biogas utilization schemes in biogas production from vinasse.

Aerobic treatment of low OLR wastewater



Microbubble Aeration

We explored a porous membrane-based bubble generator (MBG) as a potential energy-efficient oxygen dissolution technology.

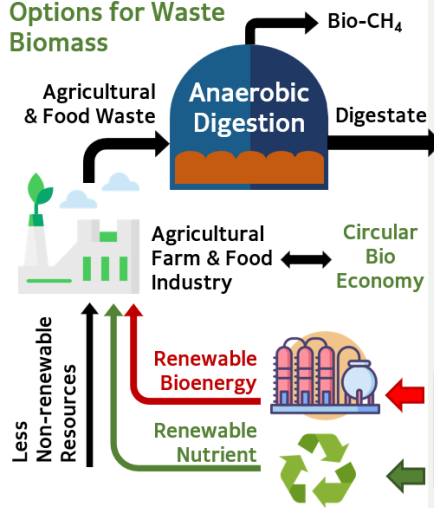
Swirl-type Microbubble Aeration

We evaluated the improvement of dissolved oxygen in water by means of newly developed swirl flow-type. We used the dynamic physical absorption model to measure the coefficient of oxygen volumetric mass transfer

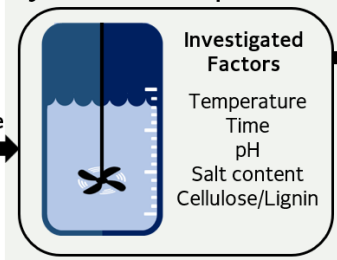
Decentralized Greywater Treatment

We designed a low-cost aerobic bioreactor equipped with a microbubble generator a highly efficient aerator and pumice stones for bacterial attachment media. The pumice stones served as immobilization media for activated sludge bacteria so that additional sedimentation step was not required, and better effluent quality was achieved.

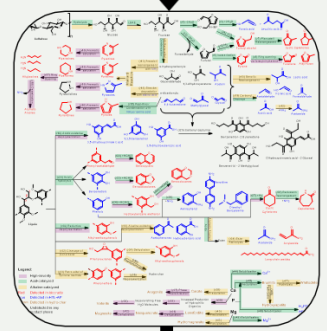
Sustainable Processing Options for Waste Biomass



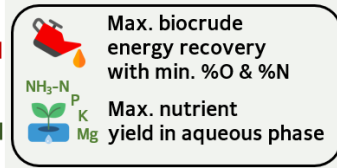
Hydrothermal Liquefaction



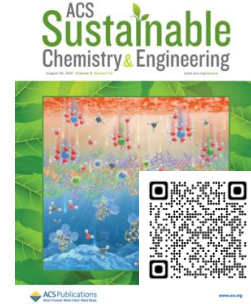
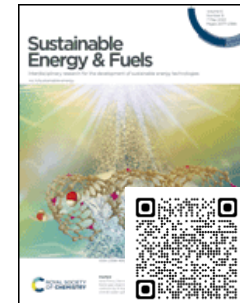
Proposed Reaction Pathway



Targeted Resource Recovery



Catalytic HTL of wet biomass waste



Mechanistic Investigation

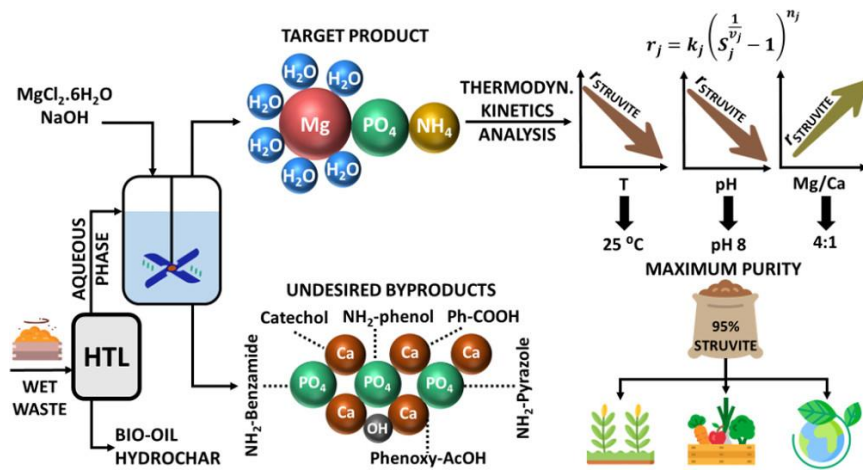
We investigated the transition from hydrothermal carbonization to liquefaction as well as the controlling mechanisms for the formation of hydrochar and bio-oil

Catalyst development and feedstock-based optimization

We improve the HTL performance through the use of solid heterogeneous catalysts and by specifying a range of optimal process conditions for different feedstock compositions.

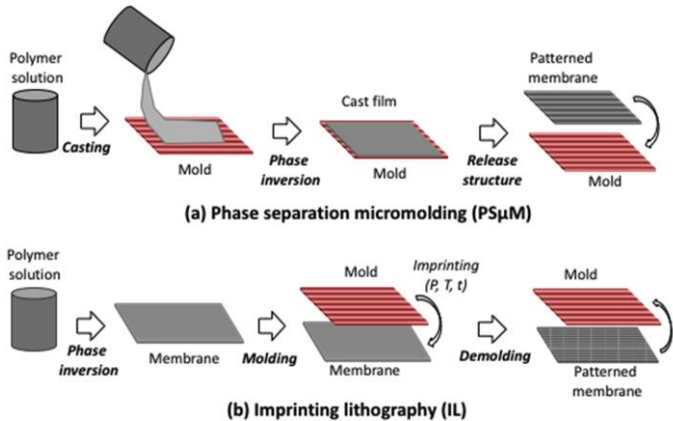


Nutrient recovery from the thermochemical treatment byproducts



Thermodynamics and kinetics of struvite crystallization

We studied the crystallization rate of struvite and adsorption of impurities from the liquid byproduct of HTL of digestate under different conditions.



Patterned flat sheet membrane

We developed a new method to prepare flat-sheet patterned membranes using a patterned knife combined with a modified phase inversion process to acquire membrane with high fluxes and low fouling.



ONGOING PROJECTS





Projects and PIs

Biogas production from marine macroalgae and water hyacinth

PI: Dr. Lisendra Marbelia

***E. coli* spread detection and mitigation in groundwater and drainage systems**

PI: Dr. Lisendra Marbelia

Integrating sequential batch reactor and aquaponic systems with fish farming

PI: Dr. Wiratni Budhijanto

Aqueous-phase reforming of phenol-rich industrial wastewater

PI: Dr. Hanifrahmawan Sudibyo

Paracetamol synthesis via direct amidation of biomass-derived hydroquinone

PI: Dr. Hanifrahmawan Sudibyo

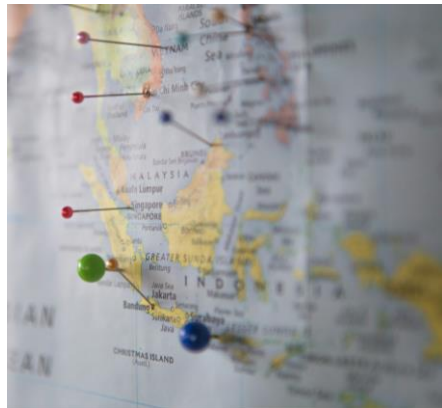
Sorting of inorganic and organic fractions of municipal solid waste

PI: Dr. Wiratni Budhijanto

FUTURE RESEARCH



We want to realize the Circular Bioeconomy concept!



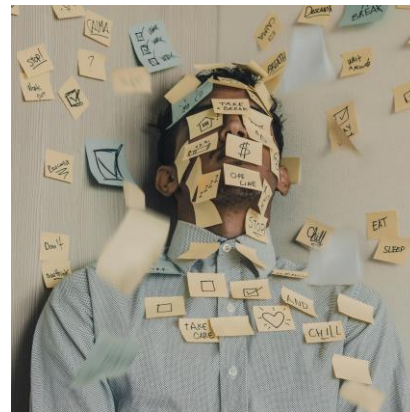
Developing decision-making tools based on spatial performance of biorefinery

To allow us to evaluate the socio-techno-economic feasibility of the biorefinery for certain locations and to identify required regulatory change and relevant climate actions



CO₂ utilization for valuable chemicals production

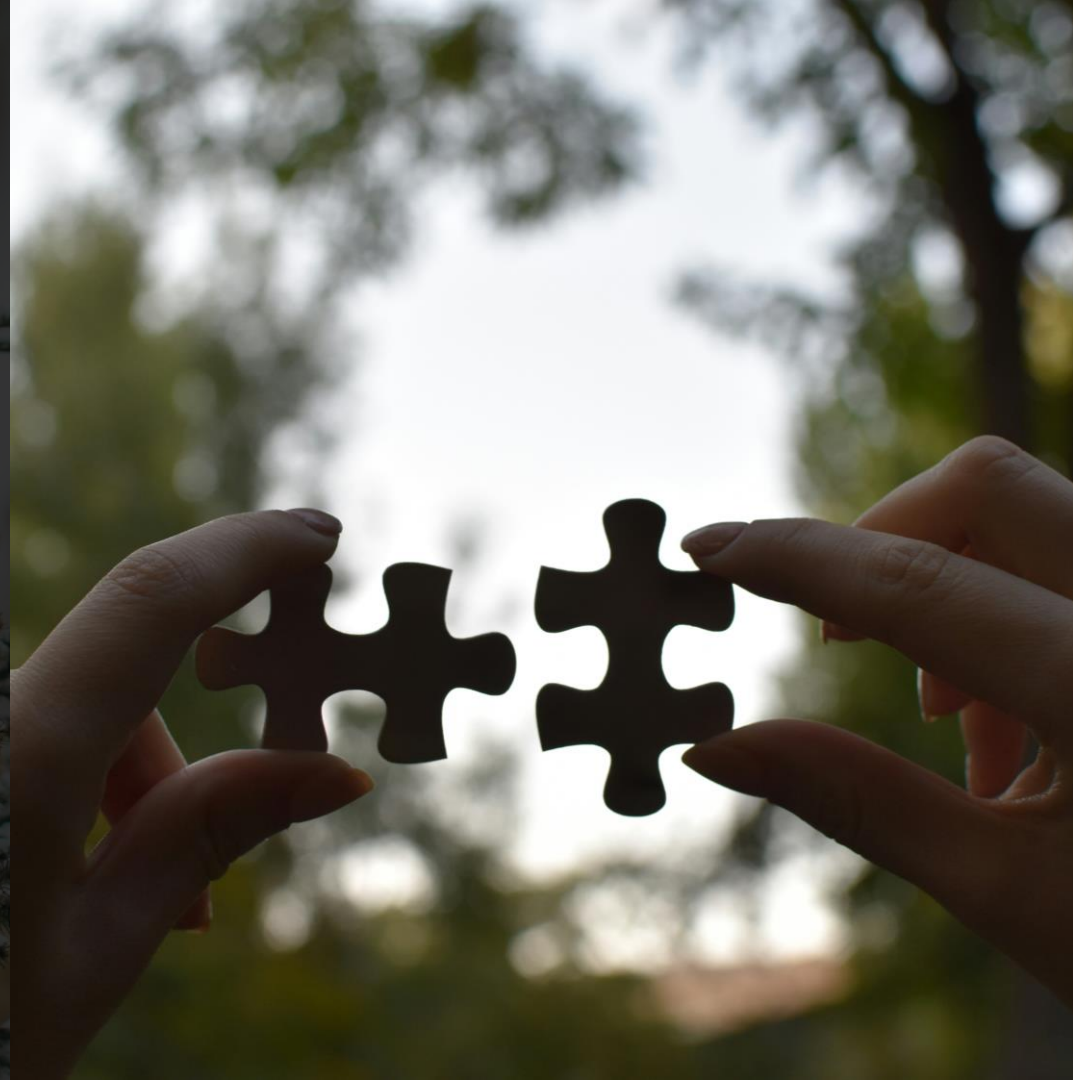
Conversion through electrochemical and lithotrophic pathways are of our interests for upcycling carbon released upon wet oxidation or biofuel combustion



Multi-functional catalysts to handle complex thermochemical phenomena

Catalyst with more than one function will be required to allow the production of drop-in fuel or chemical building blocks in one pot

POTENTIAL PARTNERS



We want to realize the Circular Bioeconomy concept!



Developing decision-making tools based on spatial performance of biorefinery

We need experts in Geographic Information System (GIS), software (GUI) development, and econometry



CO₂ utilization for valuable chemicals production

Electrochemist and biologist with expertise in lithotroph or chemolithotroph will fit well in our research roadmap



Multi-functional catalysts to overcome complex thermochemical phenomena

People with deep knowledge and robust experience in inorganic and physical chemistry will excel the commercialization of the proposed thermochemical technologies in our scheme.

Feel free to connect with us



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See our short
lab tour here.