ศูนย์เชื้อเพลิงและพลังงานจากชีวมวล
Center of Fuels and Energy from Biomass

การเสวนา

นวัตกรรมเพื่อการกำจัดของเหลือทิ้งหรือของเสียเป็นศูนย์
(Innovation for Zero Waste)

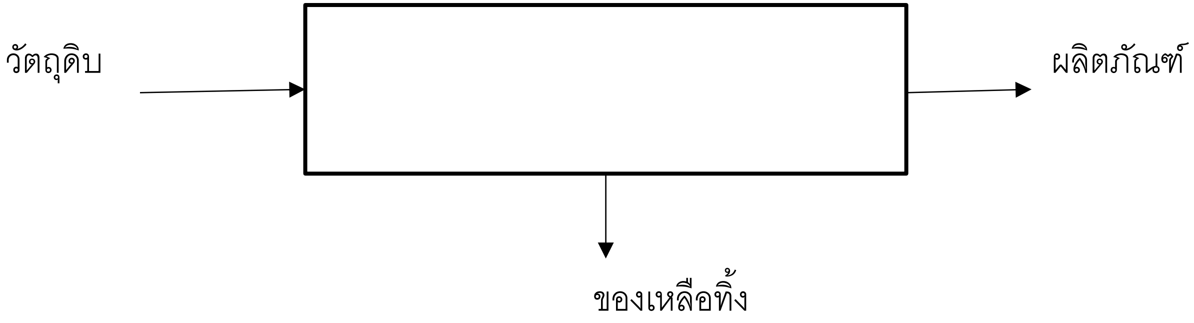
Prof. Dr.Tharapong Vitidsant

Center of Fuels and Energy from Biomass, Chulalongkorn University

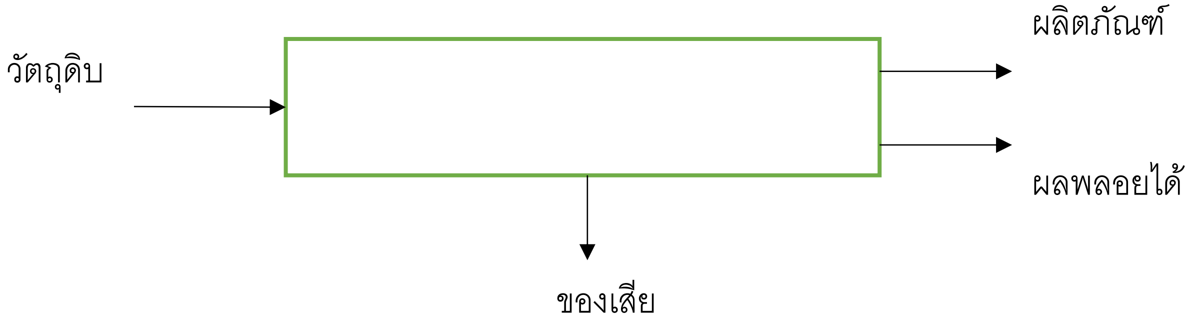
ห้องสัมมนา ชั้น 5 อาคารวิศวกร (ซอยลาดพร้าว 54) 13.00-15.30 น

กระบวนการเปลี่ยนแปลงวัตถุดิบให้เป็นผลิตภัณฑ์

- **กระบวนการทางกายภาพ**



- **กระบวนการทางเคมี**



การจัดการของเสียหรือของเหลือทิ้งต้องรู้ก่อนว่า

- **ที่มา มาจากกระบวนการหรือปฏิกิริยาประเภทใด**
  - **กายภาพ**
  - **เคมี**
- **ลักษณะตัวอย่าง**
  - **ลักษณะทางกายภาพ เช่น ของแข็ง ของเหลว**
  - **ทางเคมี เช่น ติดไฟ ระเหยเร็ว**
- **วิเคราะห์องค์ประกอบ เพื่อให้รู้ว่า วิธีการจัดการหรือการแปรรูป น่าจะไปทางใด**

Project supporter: JICA, NEDO, NRCT, TRF, PEA, CU
ESG, RBC, TMC, PTT, SEPCO, TRC, STW, TOYO INK

Biomass or Lignocellulose

Physical Conversion

Pellets& Briquettes

Carbonization & Steam Activation

Biochar for carbon credit

Briquette charcoal

Activated carbon

Thermoplastic waste, Lube oil waste

WPO or PAO WCO, WAF

Continuous pyrolysis with catalyst (Pilot reactor)

Pyrolysis oil yield 60-70 wt%

- Naphtha = 30%
- Kerosene = 12%
- Diesel = 48%
- Fuel oil = 10%

Pyrolysis oil yield 65-75 wt%

- Naphtha = 18%
- Kerosene = 15%
- Diesel = 55%
- Fuel oil = 12%

Naphtha, Kerosene, pyro-diesel or bio-diesel

Biomass or Lignocellulose

Gasification & FT synthesis (Pilot reactor)

- Bio-syngas

- Bio-gasoline
- Bio-diesel
- Bio-LPG
- Bio-methanol

- Bio-jet

Bio-methanol, Bio-jet

Biomass Potential In Thailand

Biomass	Product (ton)	Quantity that has been used (ton)	Remaining (ton)	Heating value (TJ)	Equivalent to crude oil (ktoe)	equivalent to electricity (GW-h)	production capacity (MW)
Rice straw	19,005,628.14	8,112,801.26	10,892,826.89	134,308.56	3,188.71	7,461,685.42	942.12
Rice husk	8,146,269.20	8,006,283.36	138,985.84	1,879.09	44.61	104,393.81	13.18
Sugarcane leaves	17,016,248.08	1,845,487.74	15,170,760.34	234,843.37	6,676.68	13,046,863.89	1,647.34
Bagasse	28,028,761.54	28,028,761.54	0	0	0	0	0
Corn stalks/leaves	9,315,603.52	465,780.18	8,849,823.34	86,993.76	2,065.38	4,832,986.88	610.23
Corn cob	1,216,078.72	1,094,081.58	120,997.14	1,163.00	27.64	64,666.25	8.16
Cassava root	6,045,508.40	154,196.52	5,881,311.88	32,288.40	755.58	1,793,800.12	226.49
Cassava pulp	1,813,662.52	1,813,652.52	0	0	0	0	0
Cassava peel	8,463,711.76	8,463,711.76	0	0	0	0	0
Oil Palm Trunk (OPT)	1,957,280.00	-	1,957,280.00	14,757.89	350.38	819,882.84	103.52
Oil palm frond (OPF)	18,065,006.01	1,707,454.87	16,357,551.14	28,789.29	683.51	1,599,405.00	201.95

Objectives of the project

- To convert bulky biomass to briquette
- To convert dense biomass briquette to biochar by carbonization meeting Puro Earth, EBC, Verra Standard
- To produce briquette charcoal and activated carbon
- Cost estimation of each process

Characteristics	Bulky biomass	Dense biomass
Bulk density	< 150 kg/m3	> 400 kg/m3
Carbon content	Low	High
Degradation	high	low
Transportation cost	Expensive	Fair

Process overview

bagasse

Sugarcane leaves

Briquette& Pellet

Biochar

Soil conditioner

Briquette charcoal

Activated carbon

Briquetting & Pellet machine

Carbonizer

Charcoal briquetting machine and Activator

Potential biomass as raw material for BTL

Farming or Contact farming

By products

Briquetting machine

Carbonizer (3 size)

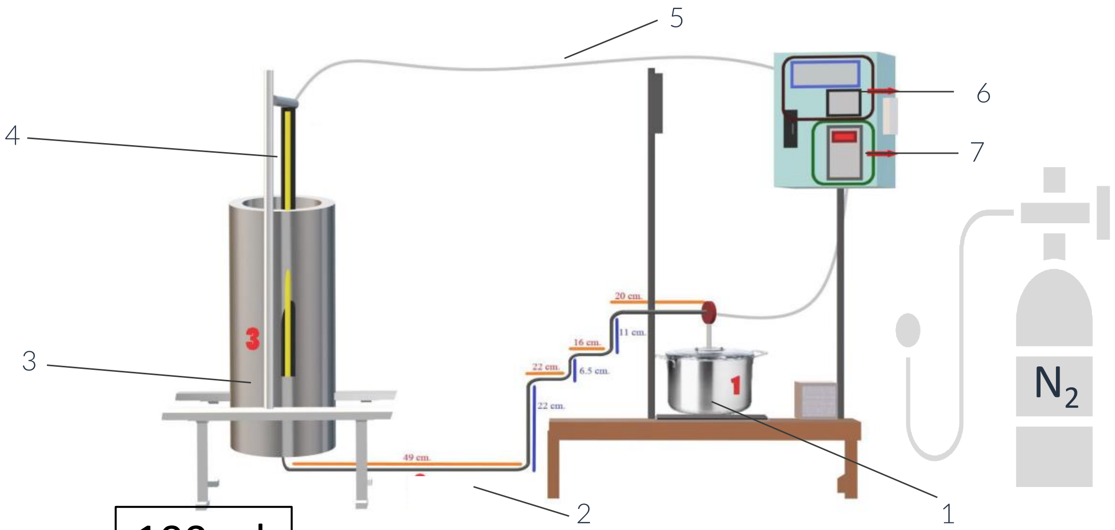
Objectives: to convert biomass to biochar

- Lab scale 100 ml Investigate parameters: Temperature and residence time
- Bench 200 liters Pilot 20 m3

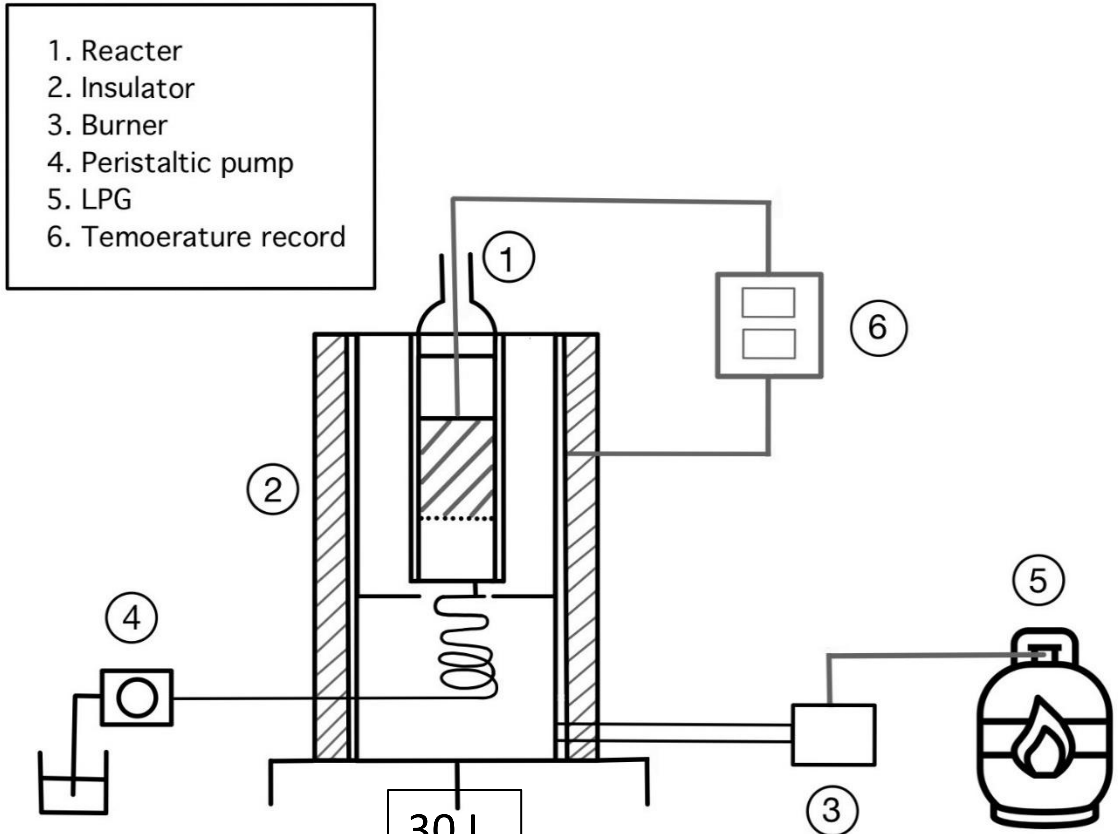
Charcoal briquetting

Solar drying room

Activator for activated carbon preparation



100 ml

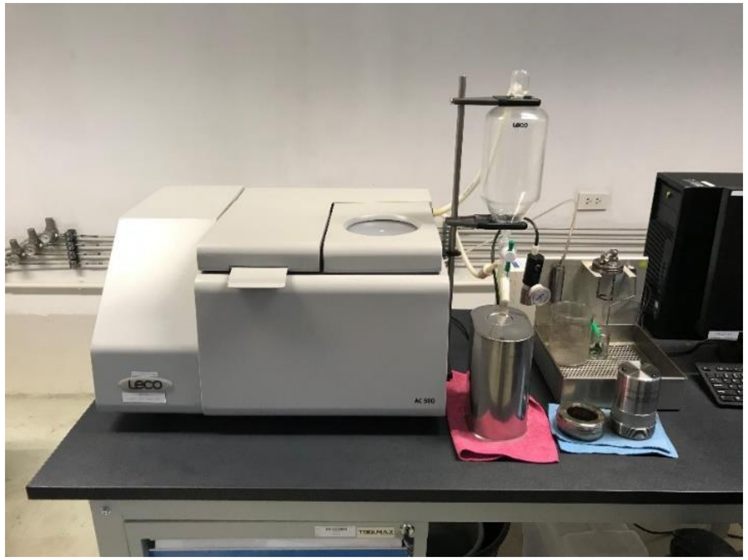


30 L

4 t/d
raw mat.

Characterization

- Bomb Calorimeter -> Heating value
- (Proximate analysis) -> M, VM, Ash, FC
- BET analysis -> Surface specific area



Bagasse

Sugarcane leaves

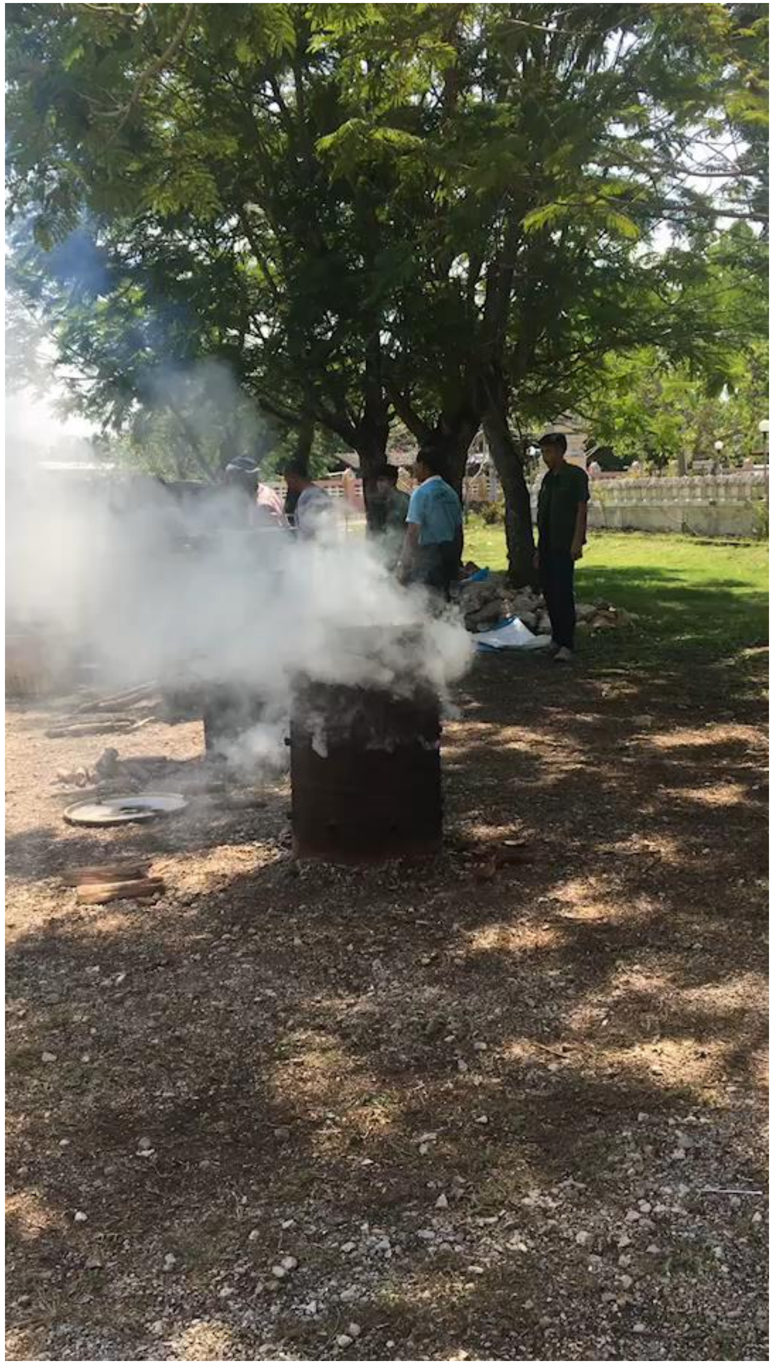

1


RYCU
TARE
NET
CU.CAP.




PUMA


849
850
900
0



Production of Diesel from Waste Plastic by Pyrolysis from Screw Pilot Reactor

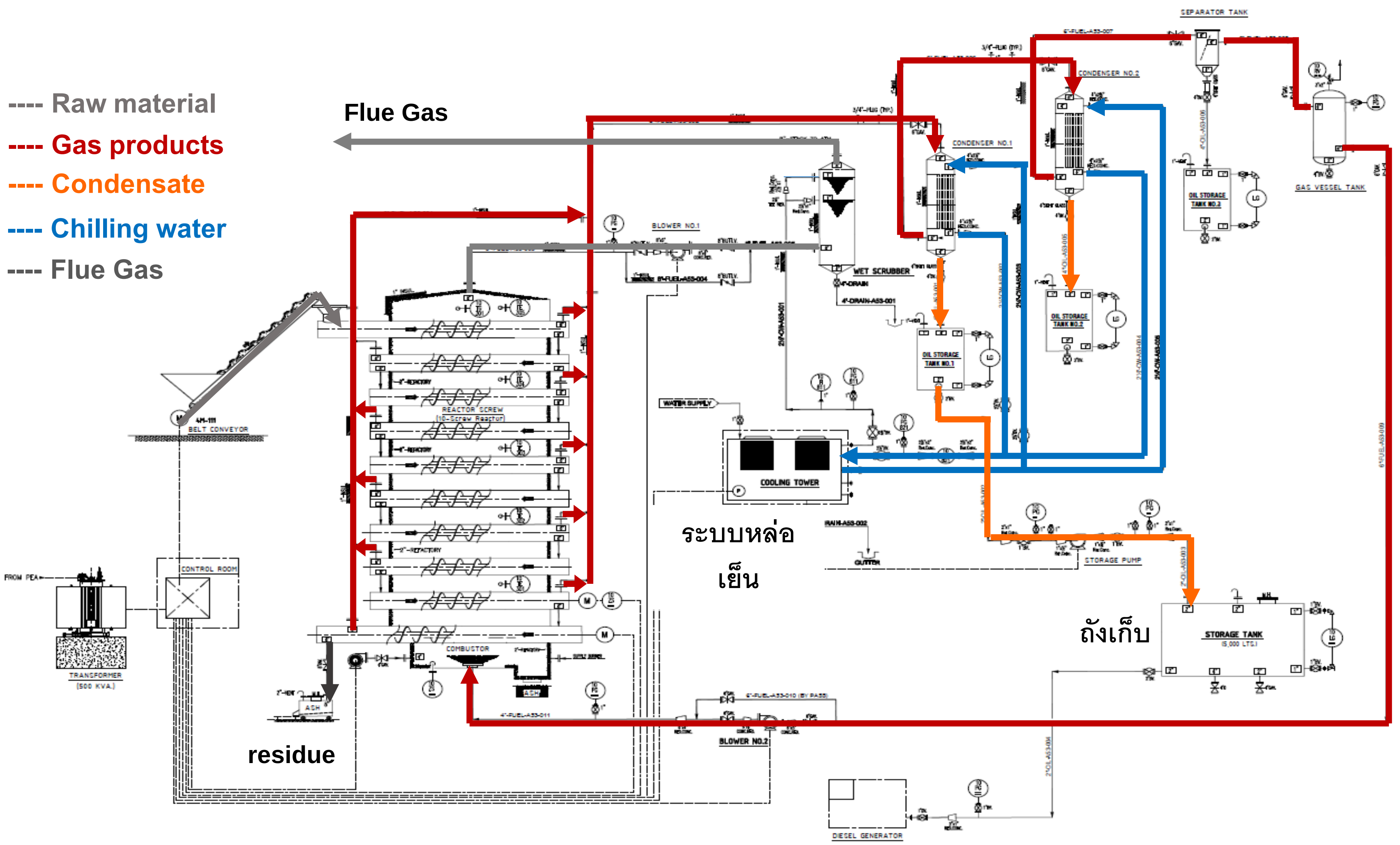
International Symposium on
Feedstock Recycling of Polymeric Materials (e-ISFR)
29-30 November, 2021 Online

Presented by

Prof. Tharapong Vitidsant

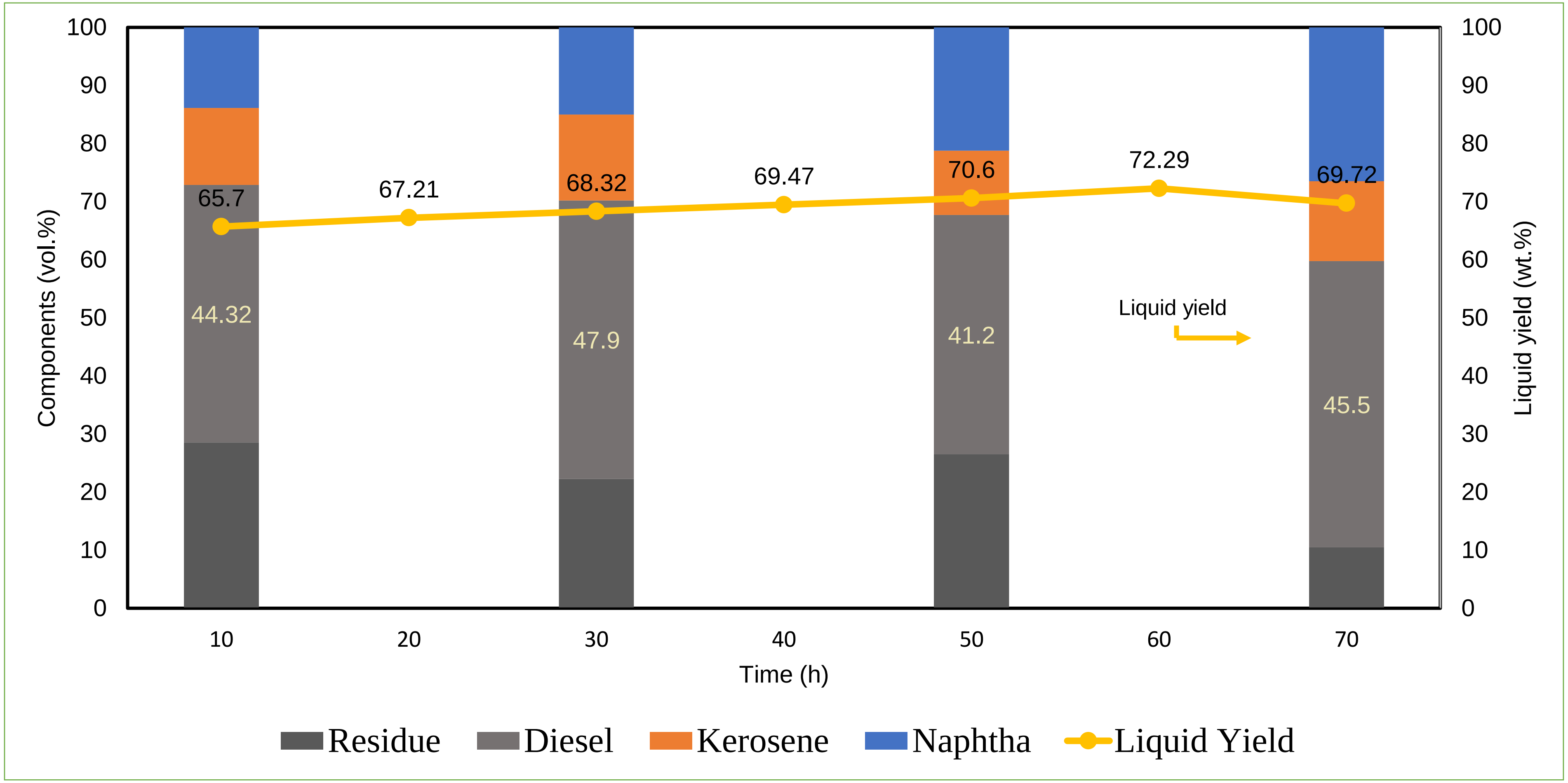
Director of Fuel and Energy from Biomass Center
Faculty of Science, Chulalongkorn University
Bangkok, Thailand

Screw pilot reactor for pyrolysis reaction (4,000 Kg feed /d)



Continuous operation results

Temperature	430 °C
Operation time	70 h
Total feed	6,100 kg (80 kg/h)
Total liquid product	4,212 kg (69.72 wt%)



Naphtha ~ -32 %
Kerosene ~ 15%
Diesel ~ 45%
Fuel oil ~ 8%

First Plastic Waste pyrolysis Oil Shipment to Shell Singapore (PTE) LTD.

15/5/2023

Liquid Fuels for Electricity Generation from Waste Palm Oil and Animals Fat by Catalytic Pyrolysis in Continuous Screw Pilot Reactor

Prof. Dr.Tharapong Vitidsant

Fuels and Energy from Biomass Center, Chulalongkorn University

Bangkok, Thailand

11th INTERNATIONAL SYMPOSIUM ON FEEDSTOCK RECYCLINGOF POLYMERIC MATERIALS 2022

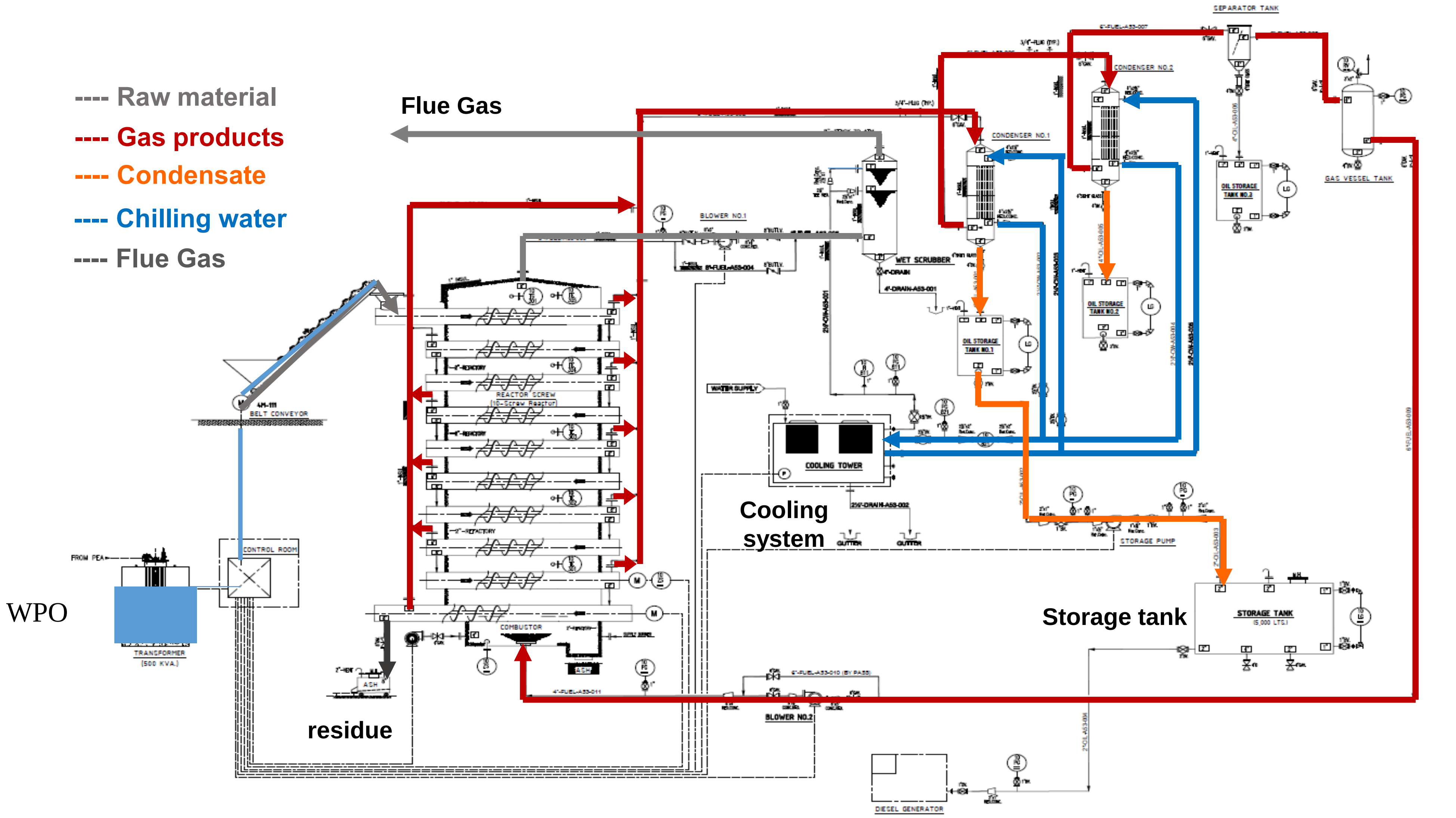
"INTO SUSTAINABILITY AND THE FUTURE OF RECYCLING"

29 November – 2 December 2022Nongnooch Garden Pattaya, Pattaya City, Chonburi, Thailand

Comparison between Transesterification and pyrolysis

	Transesterification	Pyrolysis
Products	FAME	Hydrocarbon, CO_2 ✓
By-product	Glycerol	Non ✓
Reaction time	Long	Shot ✓
Reaction temperature	Low	High X
Catalyst	Homogeneous	Heterogeneous ✓
Washing process	Necessary	Unnecessary ✓

Screw pyrolysis reactor (800kg feed/d)

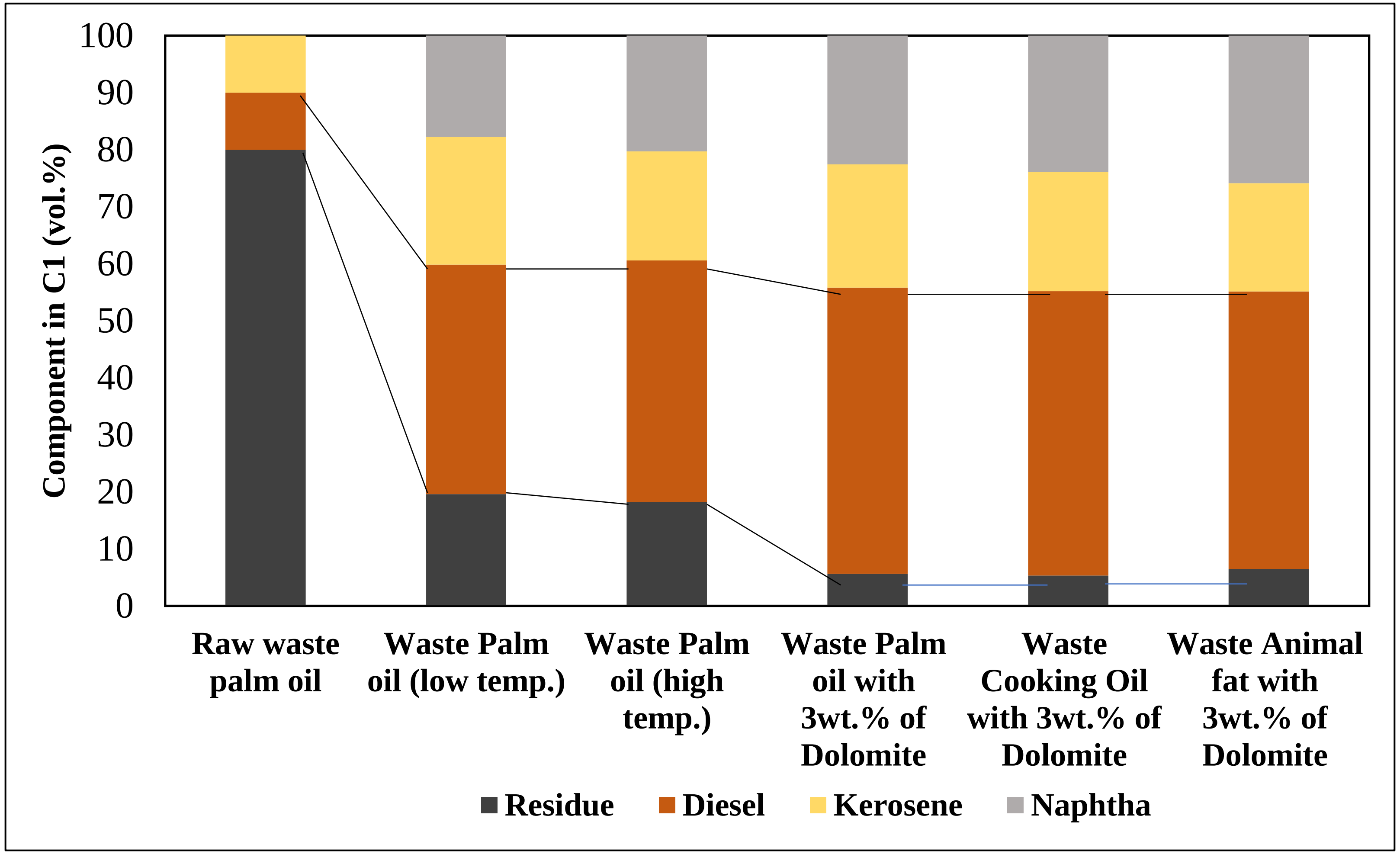


Continuous operation
a) daytime และ b) nighttime

Results and discussion

Experiment in continuous screw reactor

Composition of liquid oil in (C1)



- Naphtha = 22.35%
- Kerosene = 21.12%
- Diesel = 50.90%
- Gas oil = 5.68%

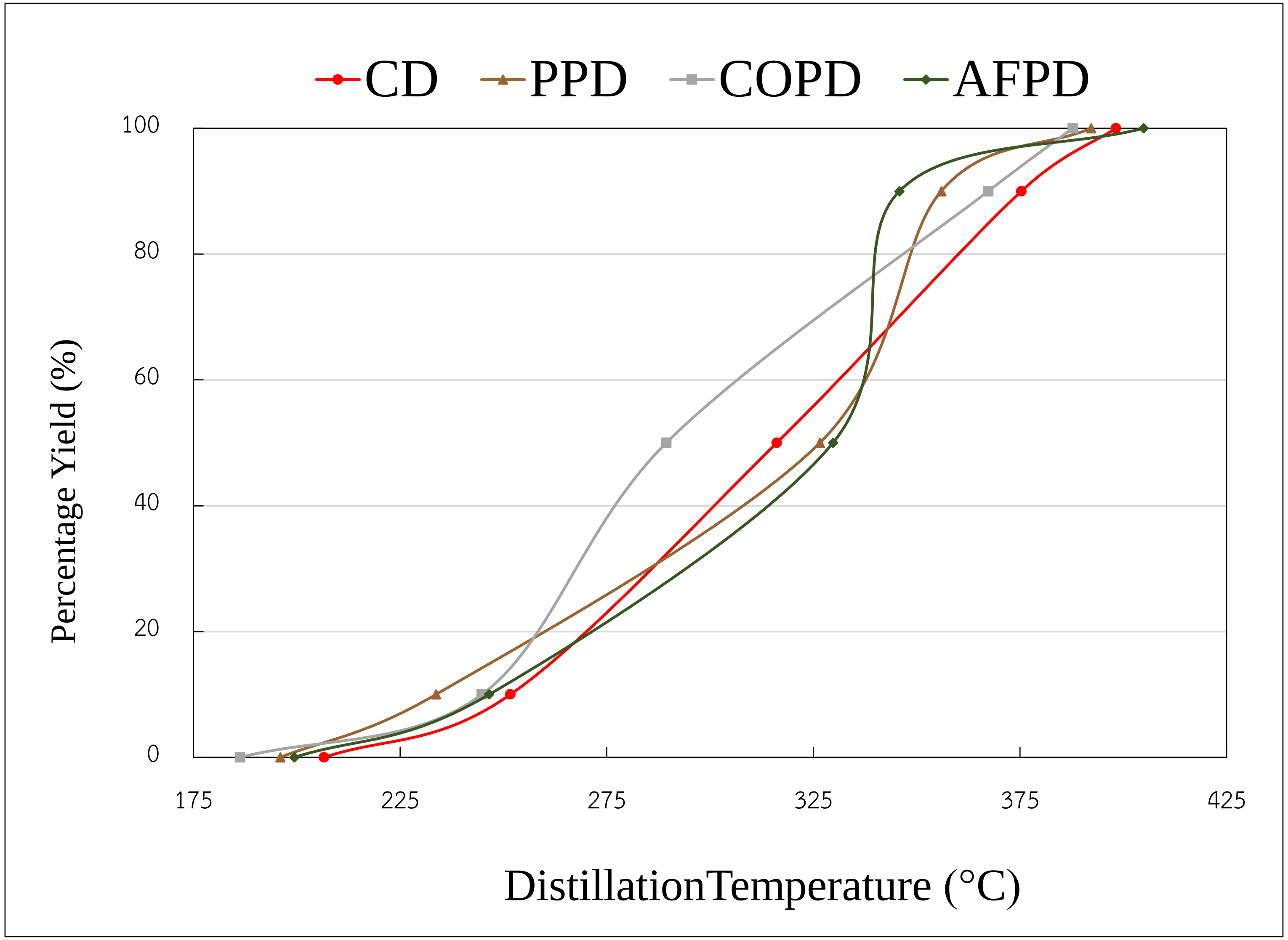
Oil treatment for diesel

Composition (wt %)	Plastic diesel		Palm diesel		Conventional Diesel
	Condenser 1	After removal naphtha	Condenser 1	After removal naphtha	
Naphtha	21.60	**11.59**	22.35	**10.05**	**9.80**
Kerosene	17.92	**19.85**	21.12	**24.82**	**15.40**
Diesel	53.25	**59.55**	50.90	**58.70**	**61.10**
Residue	7.23	**9.01**	5.68	**6.43**	**9.70**

Results and discussion

Experiment in continuous screw reactor

Distillation curve received from DGC (Simdist)



TNChE Asia 2023

TIChE

ศูนย์เชื้อเพลิงและพลังงานจากชีวมวล
Center of Fuels and Energy from Biomass

Biomass to Biofuels: Technology & Challenges

Prof. Dr. Tharapong Vitidsant

Director of Fuels and Energy from Biomass Center

Chulalongkorn University

June 22nd, 2023 Royal Criff Hotel Pattaya, Chonburi Province, Thailand

Technical Cooperation Project for

"Comprehensive Conversion of Biomass and Waste to Super Clean Fuels by New Solid Catalysts

Funded by
Japan International Cooperation Agency (JICA)
Japan Science and Technology Agency (JST)

April 2017 – August 2023

Thai Research Leader (Project Director)

Prof. Tharapong Vitidsant, Ph.D.

Department of Chemical Technology
Faculty of Science
Chulalongkorn University, Thailand

Japanese Research Leader

Prof. Noritatsu Tsubaki, Ph.D.

Department of Environmental Applied Chemistry
Faculty of Engineering
University of Toyama, Japan

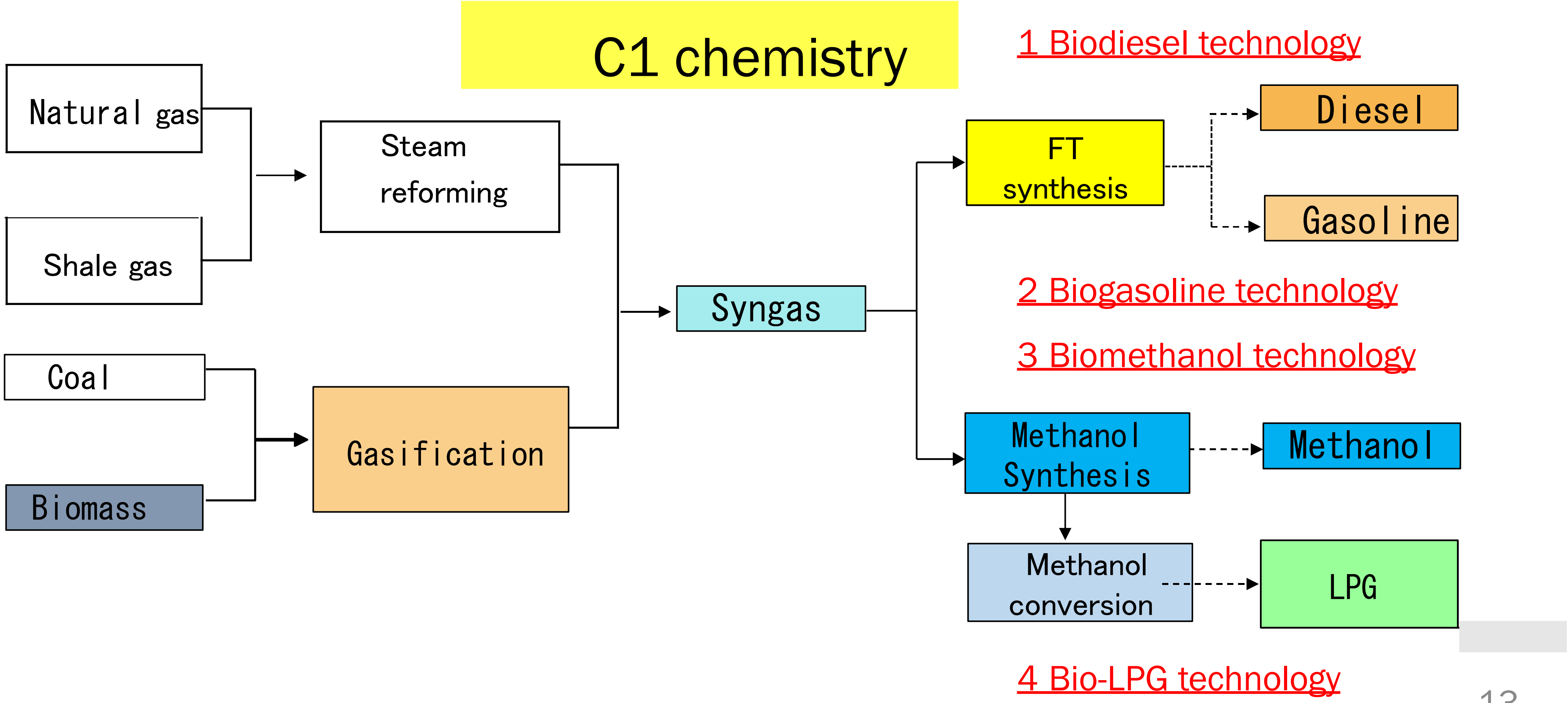
Development of catalyst technologies

【Objectiv】

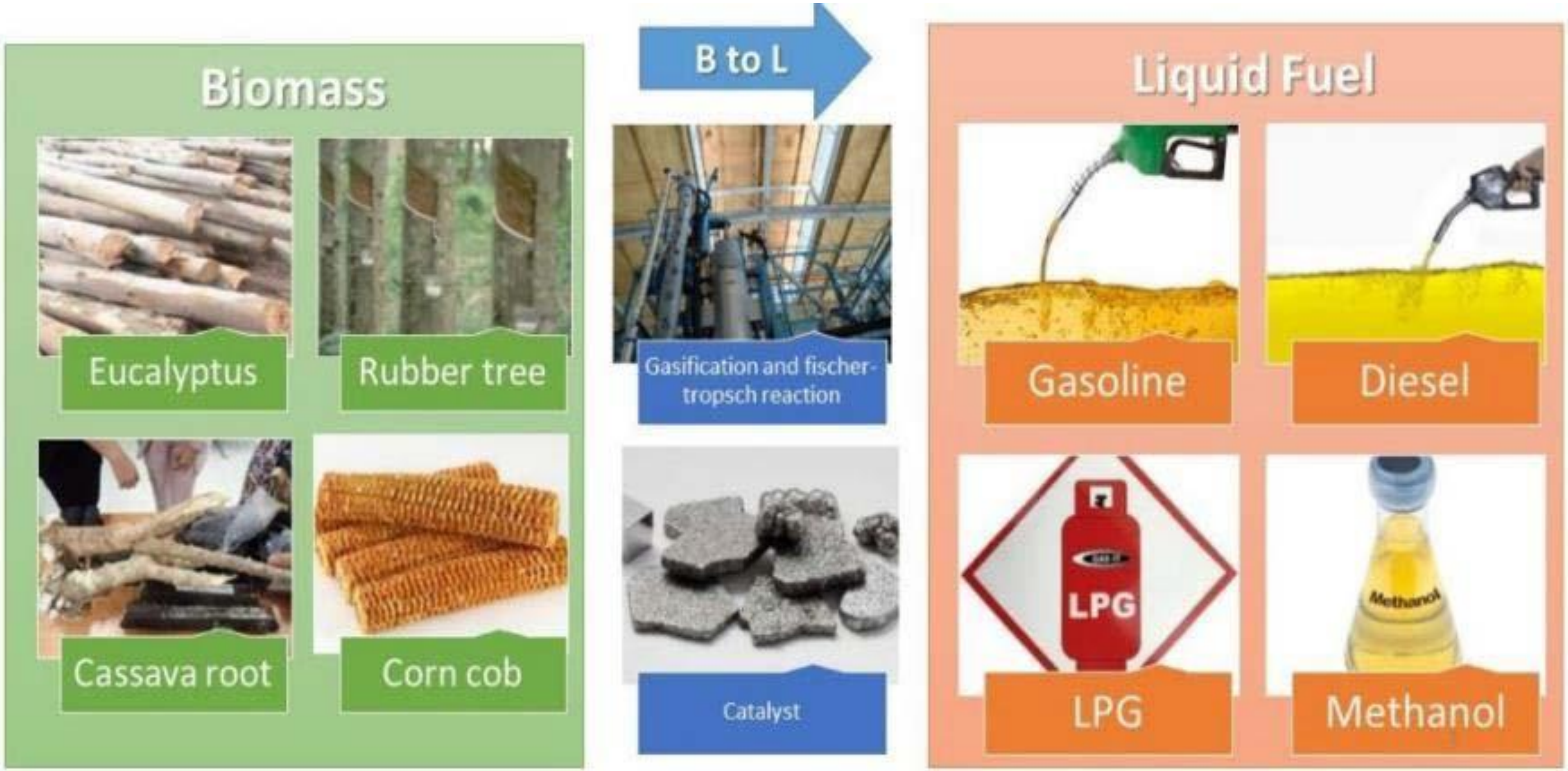
- Development of high active catalyst
- Development of active catalyst having high practical use properties
- Demonstration of biofuel production by connection driving with synthesis gas production

【Achievements】

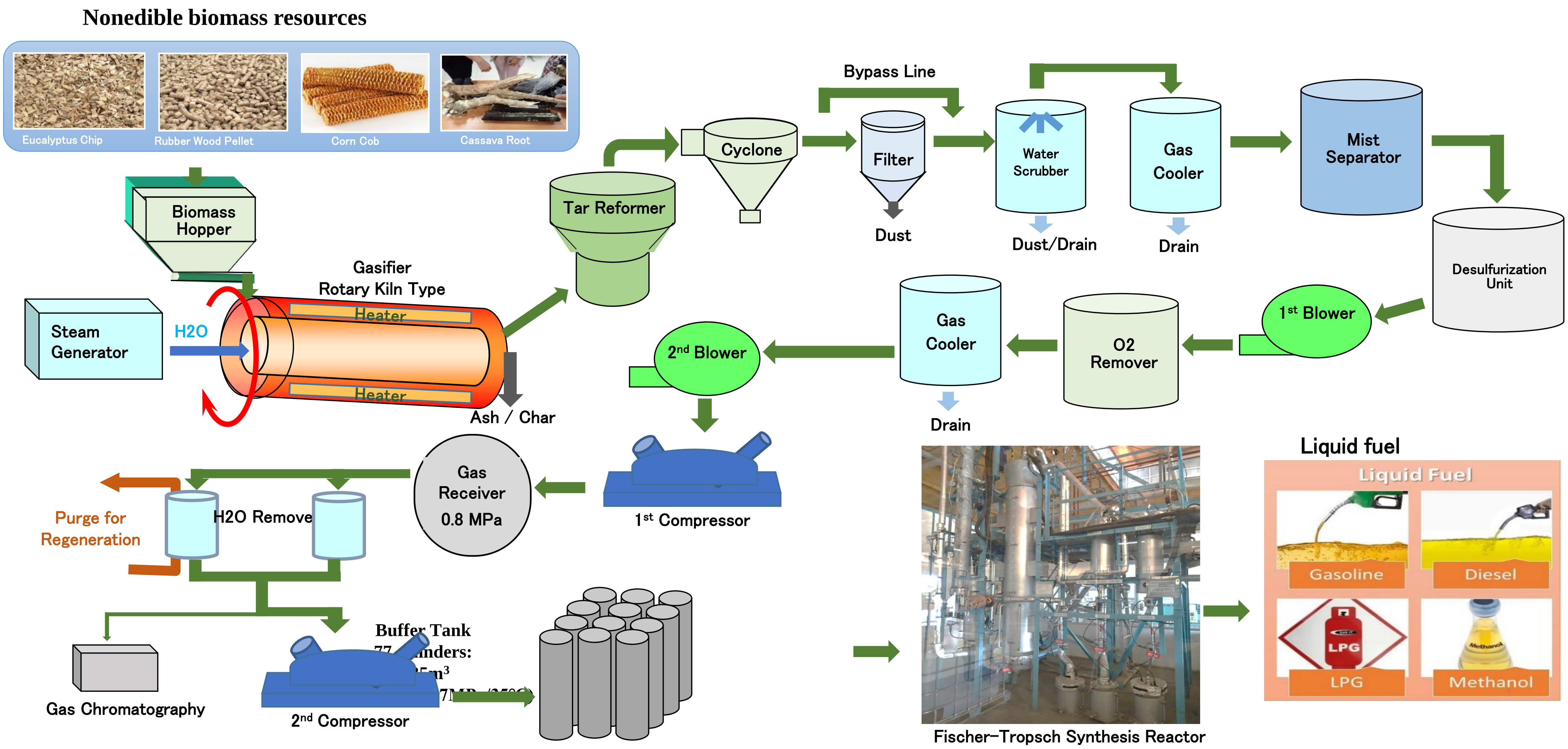
・Bio diesel, Bio gasoline, Bio LPG production
・Methanol synthesis operation and production
・Development of each elemental technology

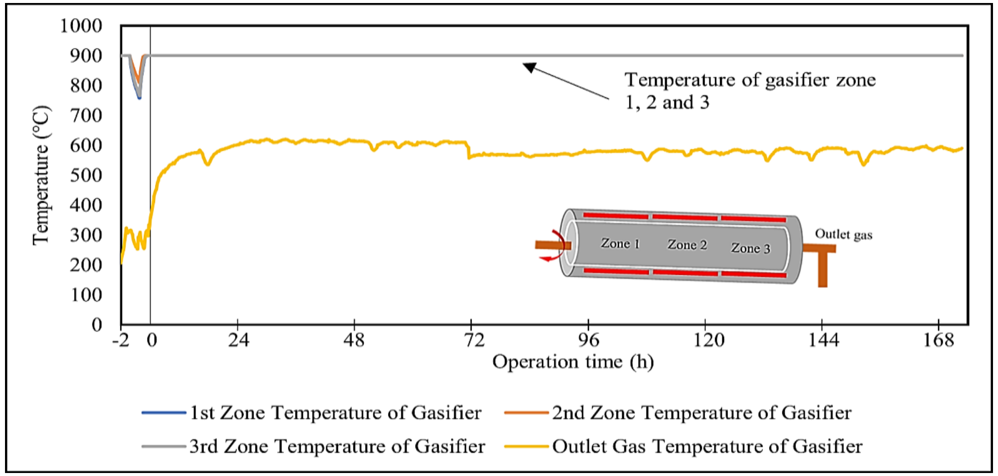


Gasification and catalyst Technologies

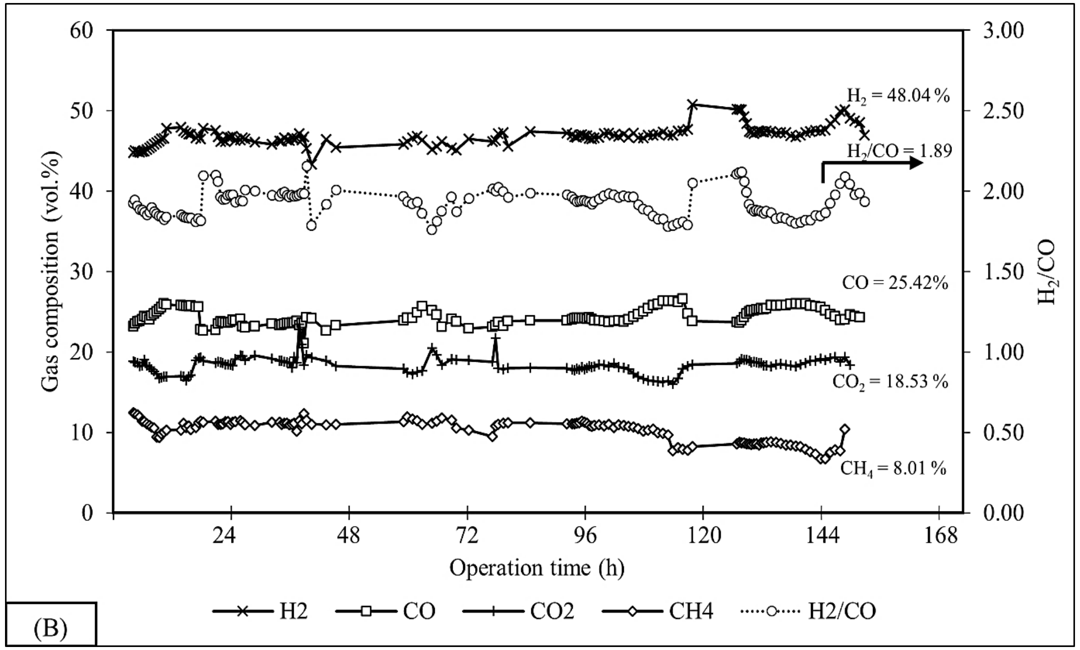


Biomass Gasification & Conversion Process





Temperature profile at the gasifier zone during EWC gasification



Gas composition and H_2/CO ratio of the EWC gasification for 7 d.

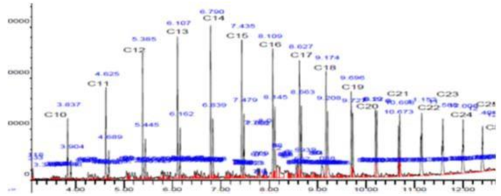
Summary of the gasification conditions and results for the two different biomasses (RWP and EWC).

	RWP	EWC
Operating parameters:		
Operating time (h)	30.5	27.77
Biomass feed rate (kg/h)	4.34	3.90
Steam feed rate (kg/h)	2.02	2.32
S/B ratio (kg/kg)	0.47	0.59
Gas yield at constant volume of 0.9071 m^3:		
Produced gas rate (kg/h)	2.48	2.67
Gas/Biomass (kg/kg)	0.57	0.68
H_2/CO (mole/mole)	1.75	1.89
Gas compositions:		
H_2	48.44	48.04
CO	27.68	25.42
CO_2	15.22	18.53
CH_4	8.66	8.01
Low Heating value (LHV):		
MJ/Nm^3	12.88	11.66
Carbon balance (kg):		
Feed stock	47.66	55.30
Produced gas	23.61	24.89
Char (solid)	24.05	30.41
Cold gas efficiency (η_{cold}):	47.77	48.05
Carbon conversion in gas product (wt.%, η_{carbon}):	49.53	45.00

- Long-time operation for synthesis gas storage
- Operation for Biodiesel production

Biodiesel production

Analysis and evaluation



Supply condition to FT/MT (Case 1: for FT)
Total volume : 488 Nm^3
Flow rate : 24 Nm^3/h
Pressure : 3 MPa or more
Temperature : 50 C or less

Synthesis gas supply to FT reactor

International joint R&D of CO_2 direct utilization jet fuel synthesis for carbon recycle

Supported by **NEDO**

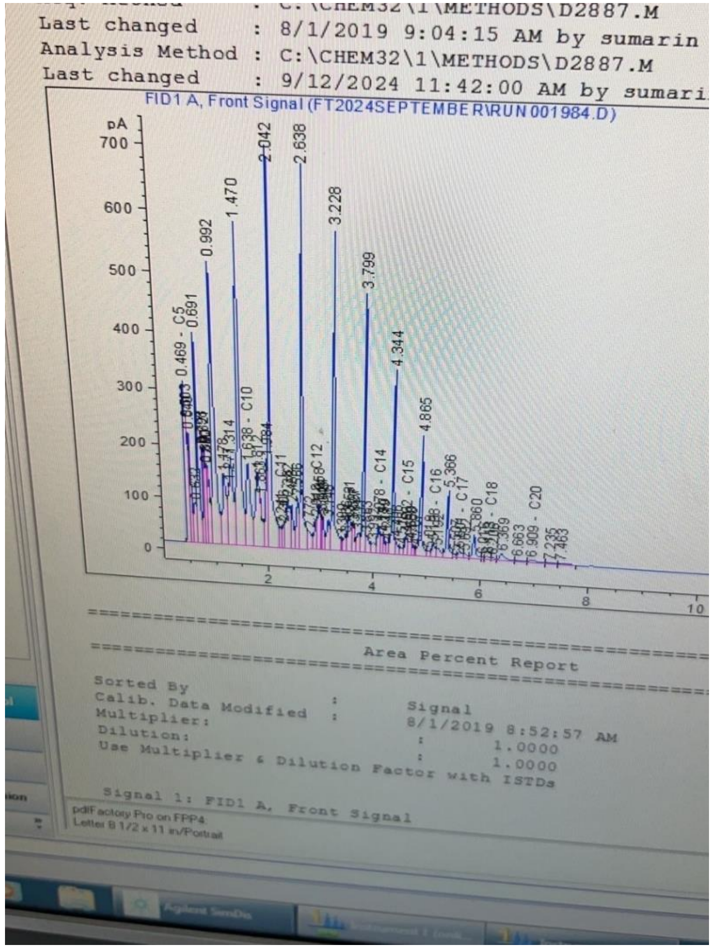
Cooperation between

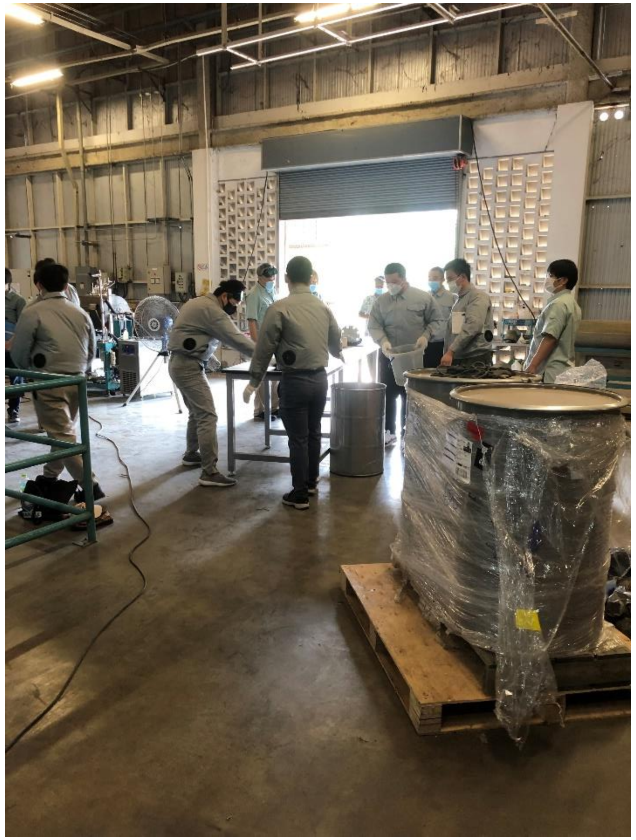
Chulalongkorn University and University of Toyama

Research area: Fuels and Energy from Biomass Center, CU Saraburi

November 2021 – December 2024
Phase 1

During operation and product SAF





Carbon number distribution
mainly C8-C16