BRAINPOWER CONGRESS 2023

ร่วมกันสร้างและขับเคลื่อนงานวิจัยขั้นแนวหน้า
สู่อุตสาหกรรมแห่งอนาคต

The development of the stability of metal surface cleaning gel

Nattsorn Ruamsilp[a], Witavanee Tappreyakunkarn[a], Narin Jantaping[a], Yuttanant Boonyongmaneerat*[b]

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[b]Metallurgy and Materials Science Research Institute

INTRODUCTION

Background

The metal surface cleaning process is very important for many applications, for example, pretreatment of metal before plating, coating, and painting. There are several cleaning methods, such as scrubbing with a scrub pad which may cause sparks and dust to spread out. One of the most effective methods is rust-removing gels. However, they contain non-environmentally friendly ingredients, and their prices are quite expensive. Therefore, the NEXGEL ACD-01 rust removal gel product was invented. It contains an acid solution and a biodegradable gelling agent that can remove rust on steel and stainless surfaces effectively. However, NEXGEL ACD-01 requires a longer shelf-life to prolong the decomposition of gel when exposed to high temperatures and strong acids. Therefore, this study is focusing on the influences of component types (hydrocolloids) on the stability of NEXGEL ACD-01 product.

METHODS

Sample preparation

Sample category:
All samples contain 2 % w/v hydrocolloids
1. NEXGEL ACD-01 (Control)
2. NEXGEL ACD-01 + CMC
3. NEXGEL ACD-01 + HPMC
4. NEXGEL ACD-01 + Pectin

Procedures:
1. Make up 13 % w/v hydrochloric acid solution by using HCl Concentrated 37 % dissolve in DI water.
2. Adding ingredients of NEXGEL ACD-01 and 2 % w/v of hydrocolloids in each types into the acid solution. Then, stir the gel mixture until it dissolves homogeneously.
3. Finally, keep in a hot air oven at 40 degrees Celsius for 4 weeks.

RESULTS & DISCUSSION

Property Analyses:

Appearance:

- Control looks like diluted syrup
- NEXGEL ACD-01+CMC and NEXGEL ACD-01 + HPMC are look like syrup
- NEXGEL ACD-01+Pectin looks like Ketchup, Highest viscous and stability which is optimum appearance, and suitable viscous for use as rust remover gel products.

Storage time	ACD-01 Extending shelf-life, storage at 40 C			
Samples	Control (C)	C + CMC	C + HPMC	C + Pectin
week 0				
Color	cream	cream	cream	Brown
Appearance	Sticky rice Lowest flow	Porridge Low flow	Porridge Low flow	Porridge Medium flow
week 4				
Color	Light brown	Light brown	Light brown	Brown
Appearance	Diluted Syrup Highest flow	Syrup High flow	Syrup High flow	Ketchup High flow

Table 1. The appearance of gels during keep in oven for 4 weeks.

Viscosity:

- Control has 1.450 cm/min
- NEXGEL ACD-01+CMC and NEXGEL ACD-01+HPMC viscosity values of 1.467 and 1.547 cm/min respectively
- NEXGEL ACD-01+Pectin has 1.400 cm/min which is lowest viscosity value indicating the highest viscous.

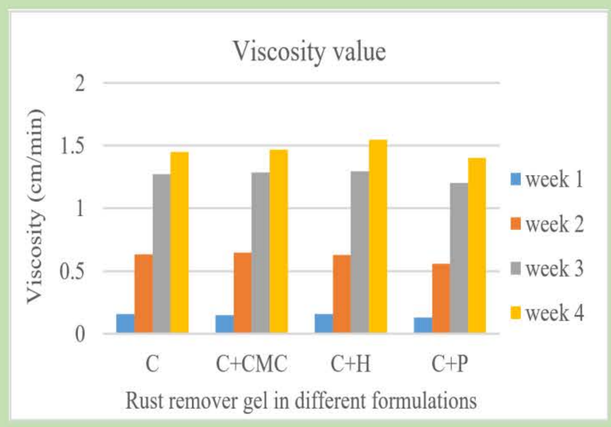

Figure 1. The viscosity of gels during keep in oven for 4 weeks.

Syneresis:

- Control has 76.94 %
- NEXGEL ACD-01+CMC and NEXGEL ACD-01+HPMC viscosity values of 77.44 and 80.09 % respectively
- NEXGEL ACD-01+Pectin has 67.85 cm/min which is the lowest syneresis value indicating the highest viscous

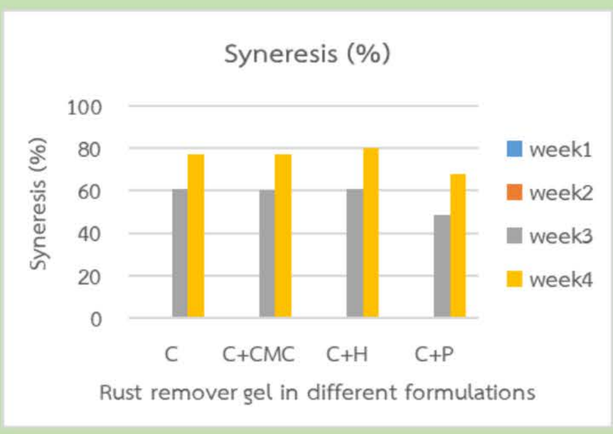

Figure 2. The syneresis of gels during keep in oven for 4 weeks.

The stability of the gel during keep in hot air oven depends on many factors, such as the type of hydrocolloids (molecular weight), type of chemical bond, initial concentration of hydrocolloids, storage temperature, and the pH value of the system, etc. The sample of control mixed with pectin has the best stability because pectin has the highest molecular weight (150 kDa) than any other hydrocolloids (HPMC; 86 kDa and CMC; 90 kDa).

CONCLUSION

The influences of gelling agent (Hydrocolloid) plays and important role to final property of gel. We got the optimum formulation for extending self-life of NEXGEL ACD-01 that is the control mixed with pectin

ACKNOWLEDGEMENTS

This research has received funding support from the NSRF via the Program Management Unit for Human Resources & Institutional Development, Research and Innovation [grant number B13F660137]

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Network: TEPNET
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International Partner: Fraunhofer IPA, Germany
Fraunhofer Institute for Manufacturing Engineering and Automation IPA

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- Ms.Witavanee Tappreyakunkarn, M.S. in Food Technology, CU., Gel Technology Expert
- Mr.Sorrathorn Manaskiattikul, B.S. in Medical Devices, SWU., Technical Sale in Surface Finishing Industry
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DIGITALIZED TRAINING PLATFORM FOR THAILAND ELECTROPLATING INDUSTRY

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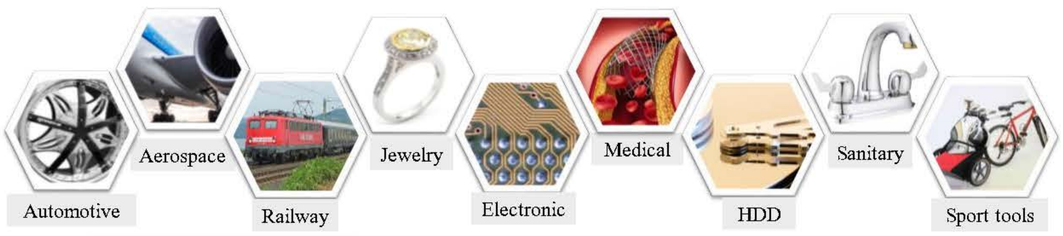
INTRODUCTION

Thailand electroplating industry is a great representative for the country's potential supporting industries due to its large size and ability to connect with the production of various products in the global value chain. However, most of the entrepreneurs have difficulty expanding and growth into higher value product/market, which leads to cost intensive market. This project will focus on developing the digitalized training platform which is tailor-made for the electroplating industry.

Electroplating Technology in Various Applications and Markets



Electroplating Scene in Thailand

- Major activities in Bangkok & vicinity provinces; EEC
- Over 500-1,000 SME plating companies
- Market size: 30 Billion THB w/ 10% growth
- Focus in automotive, electronic parts and jewelry

Electroplating Industry Value Chain

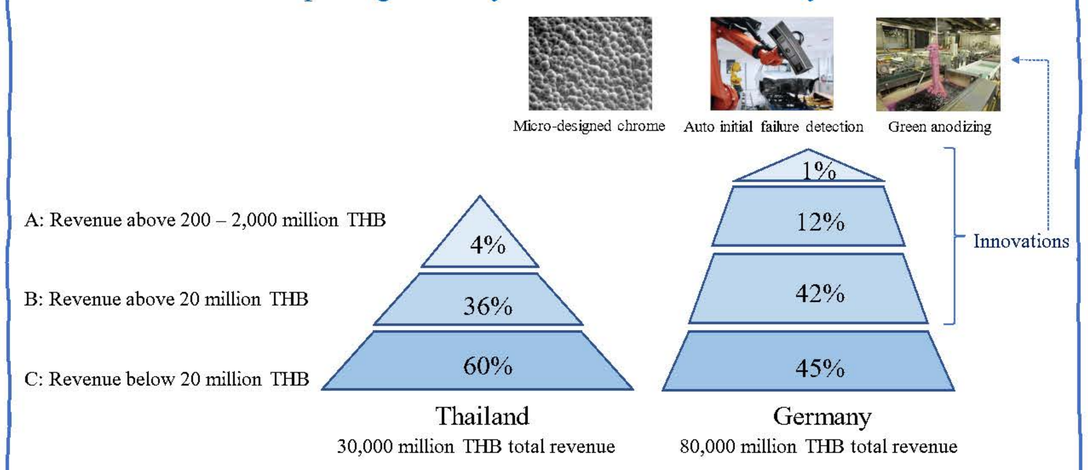
Local Electroplating SMEs → End Product Manufacturer

PAIN

While there is a huge opportunity for electroplating technology, there is a huge difference in term of structure in electroplating industry when compared with the developed country such as Germany. In terms of production value, German companies produce a variety of high-value products such as electronic equipment, aircraft parts, high end machinery equipment and medical devices. The entrepreneurs are also categorized as Innovation Driven Enterprises that focus on developing and applying advanced material surface technology to increase their production efficiency.

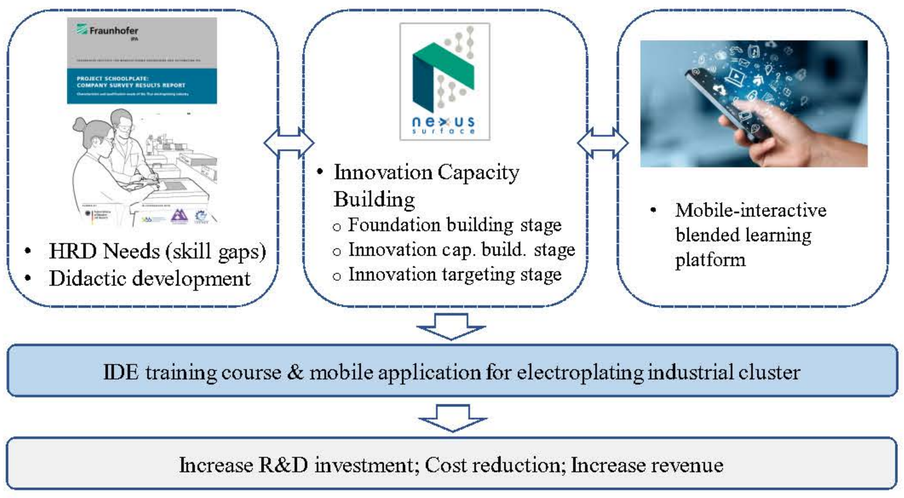
Together with Fraunhofer Institute for Manufacturing Engineering and Automation, the world leading electroplating consultant, we analyzed the gap between Thai and Germany industry. One of the most important factors and root cause of the gap is the employees' level of knowledge for both basic and advanced science. While Thai entrepreneur have a strong expertise in fixing short term problem, they mostly suffered in term of further development of technology and competitive edge. Hence, this can be solved with the training programs and workshop tailor made for them.

Electroplating Industry in Thailand vs Germany



Training area		Recomendation for single training courses (Based on survey results and experience)	Level	Estimated duration	Possible format			
					online	blended	presence	Labwork
Basics of electroplating	Basics of electrochemistry and chemistry	Elementary chemistry and electrochemistry	Starter	16 h	X	X		
		Applied electrochemistry - practical electroplating	Starter	2 d			X	X
		Applied chemistry - chemical analysis	Starter	2 d			X	X
	Occupational safety and environmental protection	Safety at work including handling of chemicals	Starter	6 - 8 h	X	X	X	
		Rinsing technology and waste water treatment	Starter	6 - 8 h	X	X	X	
	General surface technology	The electroplating process chain	Starter	6 - 8 h	X	X	X	
		Influences on the quality of electroplated layers	Starter	2 - 4 h	X	X	X	
Technology of electroplating	Influence of base material and parts manufacturing on	Influence of base material on electroplating	Focus	2 d			X	X
		Influence of parts manufacturing on electroplating	Focus	6 - 8 h		X	X	
	Plating processes — Pretreatment and special base materials	Pretreatment of ferrous materials	Focus	4 - 6 h		X	X	
		Pretreatment of non-ferrous materials	Focus	4 - 6 h		X	X	
		Plating on plastics	Focus	4 - 6 h		X	X	
	Plating processes — Layers and layer systems	Zinc and it´s alloys	Focus	2 d			X	X
		Copper-nickel-chromium layers	Focus	2 d			X	X
		Electroless nickel plating	Focus	2 d			X	X
		Precious metals plating	Focus	2 d			X	X
		Hardchromium	Focus	2 d			X	X
		Anodizing and Hard anodizing	Focus	2 d			X	X
	Work process knowledge and production technology	Electroplating plants	Focus	4 - 6 h		X	X	
		Rack design	Focus	4 - 6 h		X	X	
		Barrell plating	Focus	4 - 6 h		X	X	
		Waste water treatment	Focus	2 d			X	X
		Improvement of the layer thickness distribution	Better	8 h		X	X	
		Plant layout for electroplating lines	Better	8 h		X	X	
		Optimizing electroplating - costs and quality	Better	8 h		X	X	
Quality control and **Failure analysis** for electroplating	Failure analysis and troubleshooting	Troubleschooting	Focus	8 h		X	X	
		Reporting and communication	Focus	6 - 8 h		X	X	
		Failure analysis	Better plating	8 h		X	X	
		Communication along the supply chain	Better plating	6 - 8 h		X	X	
	Quality management	Quality managment systems	Focus	6 - 8 h		X	X	
		Leading of electroplating processes	Better plating	4 - 6 h		X	X	
	Testing technology for electroplating	The Hull cell for production-accompanying tests	Focus	2 d			X	X
		Titration measurement for electrolyte control	Focus	2 d			X	X
		Thickness measurment with electromagnetic methods	Focus	2 d			X	X
		Thickness measurement with X-Ray	Focus	2 d			X	X
		Use of coulometric methois for layer testing	Focus	2 d			X	X
		Hardness measurement of electroplated layers	Focus	2 d			X	X
		Testing methods for corrosion resistance	Focus	2 d			X	X
		Instrumental chemical analysis	Better plating	2 d			X	X
		Metallographic examination methods	Better plating	2 d			X	X

SOLUTION



RESULTS & DISCUSSION

Example of tailor-made course according to the industry's need:

"Train-the-Trainer Program"

Some of the root causes are data collecting and knowledge management problems. This course is designed to simply guide the senior about efficient methods to train new or existing employee. However, the process requires senior employees to understand exactly what to teach, how to document the data and improve the teaching method.

The role	The focus	The guiding sentence
Expert / Classic Teacher	Knowledge	"I share my knowledge with you"
Trainer	Knowledge, skills and attitudes	"I guide you towards the learning goals"
Coach	Process	"I listen and ask questions to support you"
Facilitator	Process	"I support your (group) process and your goals"

CONCLUSION

- Tailor-made course according to the real need of the industry
- Modern and highly effective learning platform for industrial level employees
- Combining the knowledge and career path into learning system

ACKNOWLEDGEMENTS

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Driving innovation in metal surface cleaning gel technology to commercial success

Narin Jantaping[a], Witavanee Tappreyakunkarn[b], Yuttanant Boonyongmaneerat*[b]

[a]Nexus Surface Innovation Co., Ltd.
[b]Metallurgy and Materials Science Research Institute

INTRODUCTION

Background

Liquid chemical such as acidic, alkaline, and solvent have been widely use in various applications, however, there are the difficulty and concern about safety for handling it. Nexus Surface Innovation Co., Ltd. developed a NEXGEL platform that utilized gel technology to transform liquid chemical to gel , that serves the need of new market and solve the pain point of the limitation of liquid applications.

Target Market & Target Application

Target Market	Market Size	Target Application
Rust remover chemical market	$531.6 Million	Maintenance, Construction, Automotive[1]

[1] *https://www.futuremarketinsights.com/reports/rust-remover-market*

Need: Innovation product and packaging for handling liquid chemicals safely and easy to use without spilling off that can use on-site.

METHODS

Solution

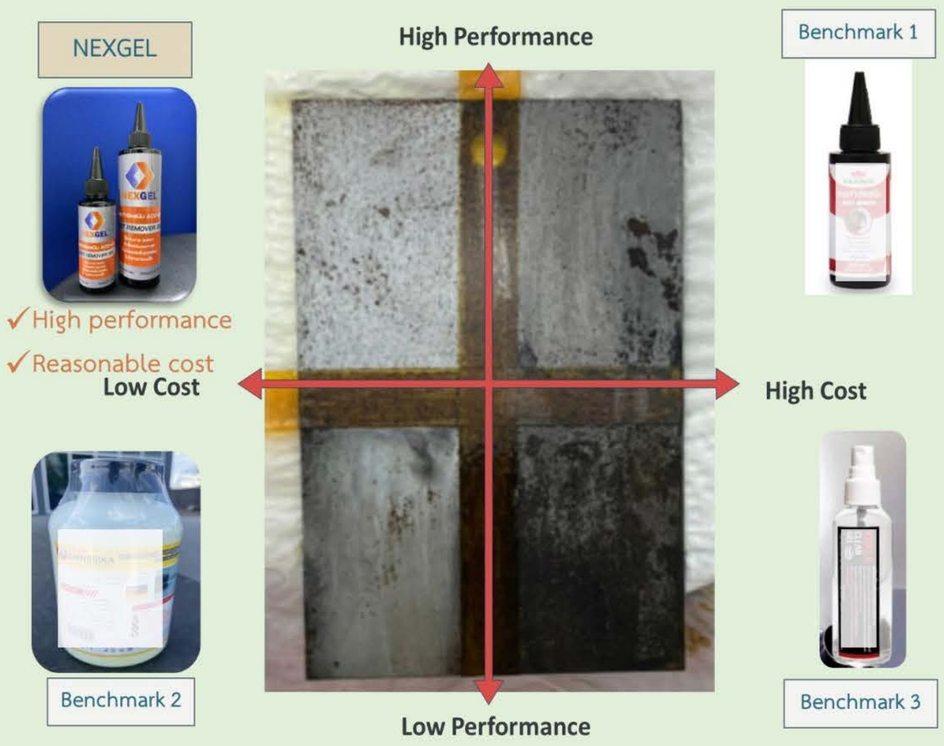
Replace liquid chemical by gel:

- Easy to handle, paint onto the target surface,
  can select the area for apply
- Ready to use onsite
- Reducing water rinsing
- Reducing chemical consumption

Technology

Gel Technology is a chemical process to transform liquid chemicals into a gel that is spreadable, more manageable, and portable. The core technology is the formulating of the right ingredients and the unique process to get the perfect gel.

COMPETIVENESS



RESULTS & DISCUSSION

Key Product

From Lab to Market

What is NEXGEL ACD-01 (Rust Remover Gel)

- ✓ Versatile cleaning products which can be removed rust effectively from steel surfaces, do not damage the base materials
- ✓ Developed based on the proprietary environmentally-friendly
- ✓ Suitable viscosity of gel
- ✓ Easy to use, handled conveniently for on-site maintenance works with a wide range of application sizes
- ✓ Trap out-gas for user safety

NEXGEL RUST REMOVER GEL

PATENT-PENDING

Patent Pending No.2303000702
Trademark NEXGEL® Pending No. 230124559

Beta-sites test


Iron Pipe

SS Jig


Conducting bar

CONCLUSION

We successfully developed gel technology for cleaning metal surface by mixing gelling agent with acid solution to form acid gel. The cleaning performance of acid gel is better than any other benchmark products in the market. Therefore, it has been launched to the market and got continuous sale with dealer, B2B, and B2C.

ACKNOWLEDGEMENTS

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สร้างคน ข้ามพรมแดน

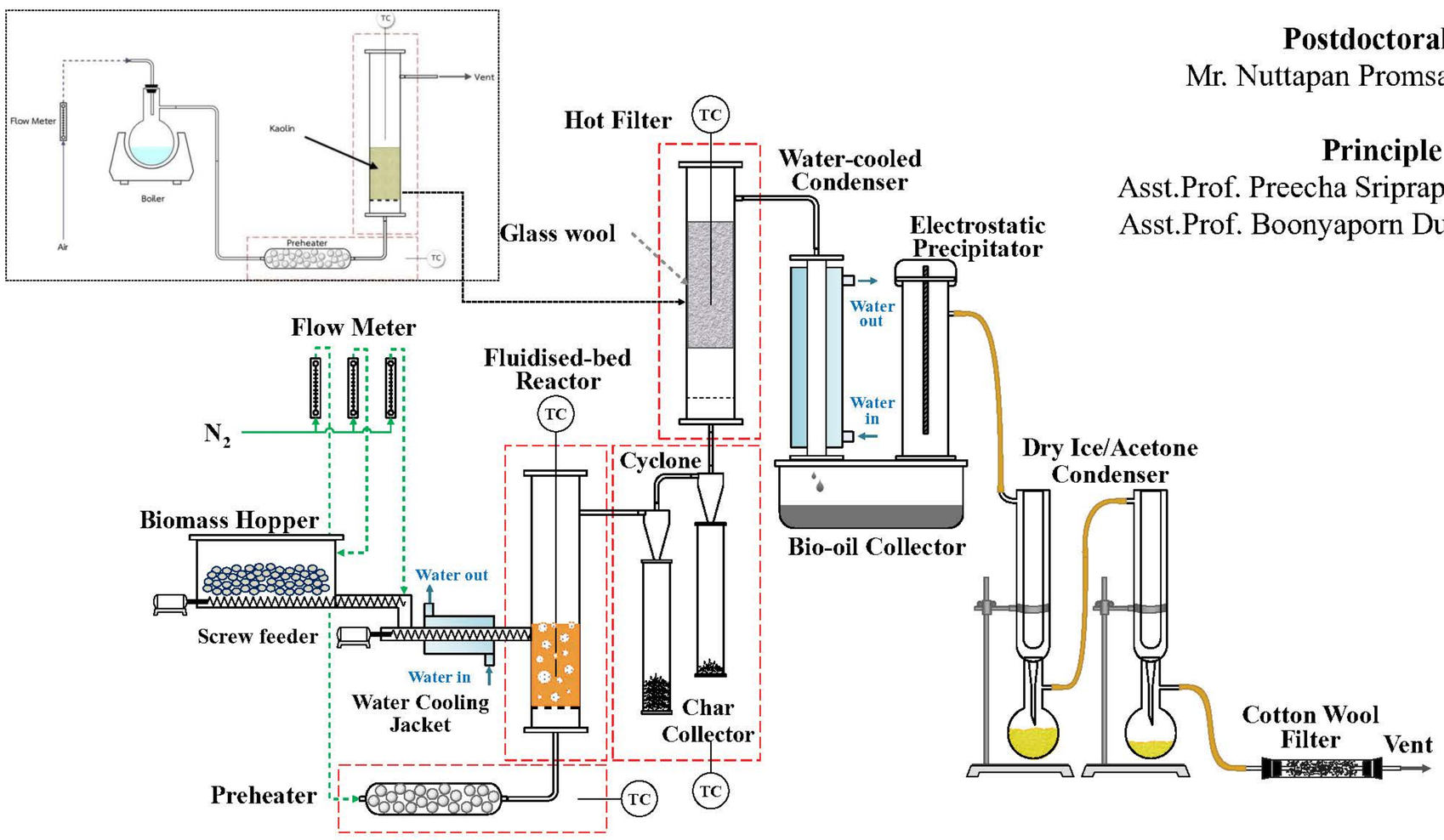
SME-D
สถาบันชุณหะวัณเพื่อการพัฒนาธุรกิจเอสเอ็มอีอย่างยั่งยืน
Choonhavan Institute For Sustainable SMEs Development

บริษัท แปลงใหญ่ผักท่ามะนาว จำกัด
PLAENG YAI PHAK THA MANAO CO., LTD.

Bio-oil production from biomass via catalytic fast pyrolysis process

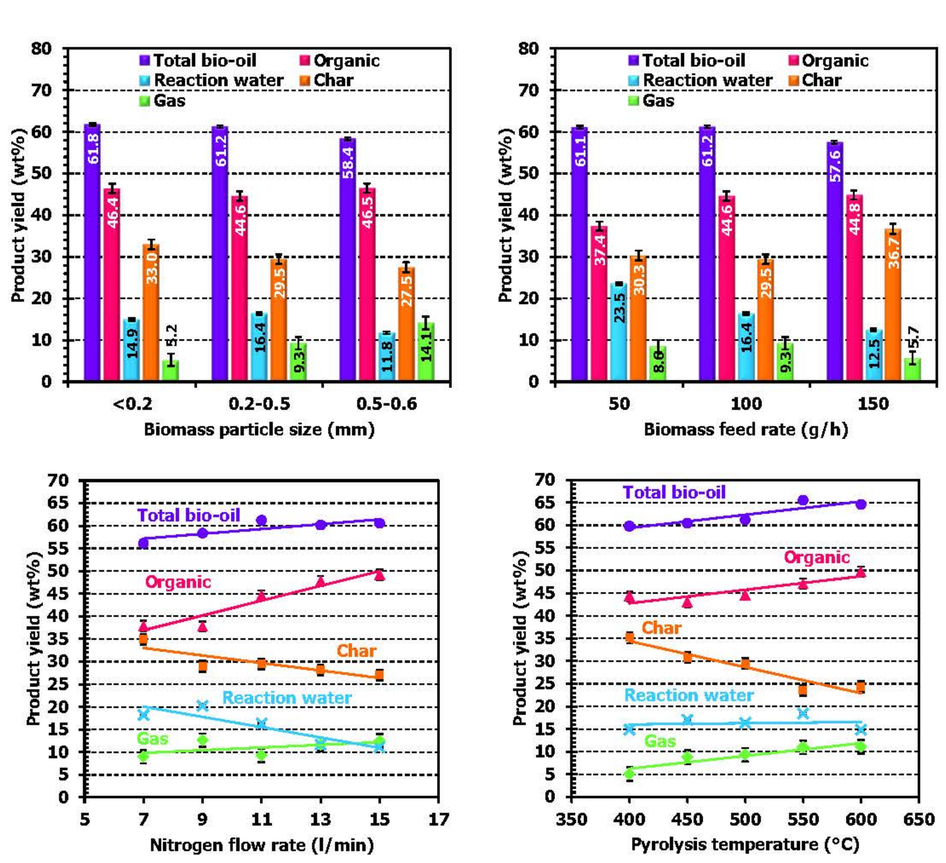
Postdoctoral Researcher
Mr. Nuttapan Promsampao, Ph.D.

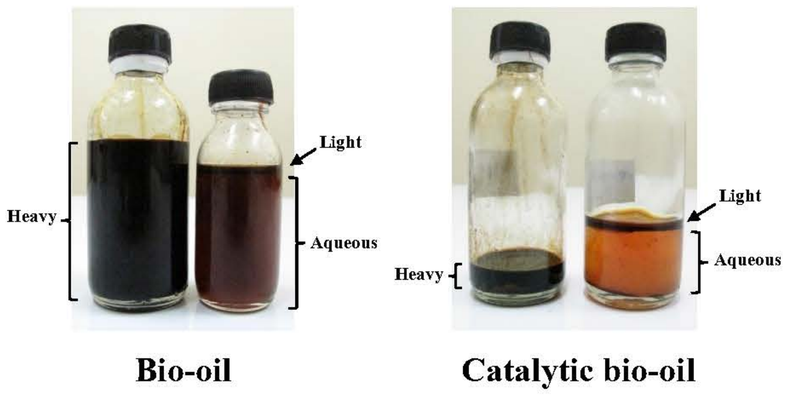
Principle investigator
Asst.Prof. Preecha Sriprapakhan, Ph.D.
Asst.Prof. Boonyaporn Duangsa, Ph.D.

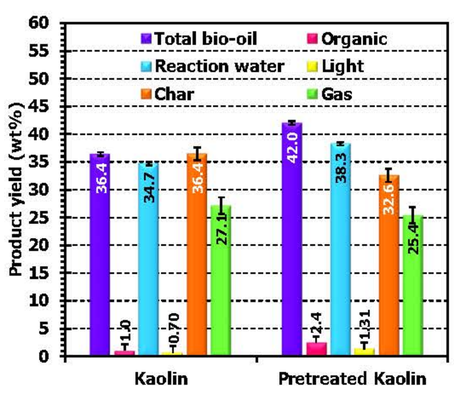


Introduction

Waste biomass resources generated from the agricultural industry of Tha Manao Subdistrict Chai Badan District Lopburi Province include durian peels, bagasse, sugarcane leaves, oil palm, and other materials. It should be managed properly in order to prevent waste and pollution concerns produced by landfill disposal and combustion, which is a contributor to the PM 2.5 problem in the area. If these biomass raw materials are processed and used, for example, to generate biofertilizer or to transform it into charcoal or bio-oil for use as alternative energy, it will be able to mitigate waste management and pollution problems.







Properties	Heavy (non-cat)	Heavy	Light	Char
pH value	4.8	4.0	n/a	-
Water content (wt%)	7.4	2.9	<1.0	-
HHV (MJ/kg)	28.7	37.2	34.4	19.2

Result

This research investigated the bio-oil production by fast pyrolysis of palm kernel cake. The objective was to investigate the effect of process parameters and pretreatment kaolin catalyst on bio-oil yields and characteristics. According to the results, fast pyrolysis using biomass particle size of 0.5-0.6 mm, biomass feed rate of 100 g/h, carrier gas flowrate of 7 l/min and pyrolysis temperature of 550°C, the organic bio-oil produced in maximum yield around 48 wt%. The qualities of bio-oil vary slightly depending on the conditions in which it is produced. When kaolin catalyst was used in affected processes, the organic bio-oil reduced to 36 wt% and the reaction water increased to 34 wt%. The used of pretreatment kaolin catalyst has a minor impact on the bio-oil characteristics.

Acknowledgements

This research has received funding support from the NSRF via the Program Management Unit for Human Resources & Institutional Development, Research and Innovation (PMU-B) [grant number B01F650006]

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SMART GREEN MICRO GRID UTILIZING RENEWABLE RESOURCES

Postdoctoral Researcher: Dr. Atsadang Traitangwong
Principle Investigator: Prof. Dr. Vissanu Meeyoo
Project Leader: Prof. Dr. Hathaikarn Manuspiya
Industrial Co-Researcher: Assoc. Prof. Dr. Sujate Jantarang
Affiliation: PETROMAT

Rationale / Problem statement / Introduction

Traditional Electric Generating Source

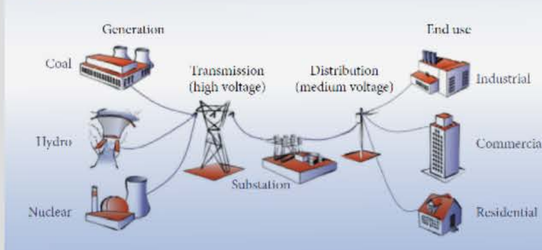


Fig 1. Traditional power plant

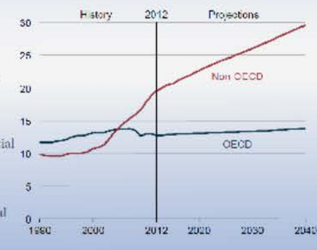


Fig 2. World energy related CO_2 emissions

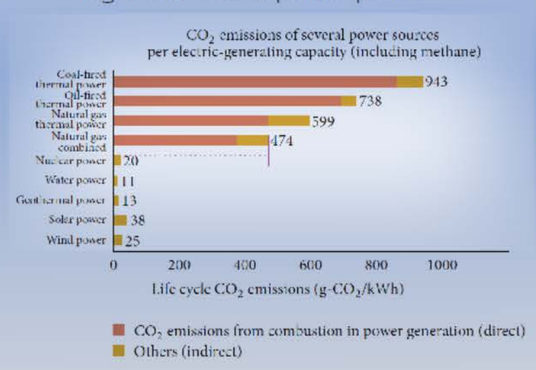


Fig 3. GHG emission from various energy sources

World energy related CO_2 emissions tend to increase to
43.2 billion metric tons in 2040

Traditional energy sources emits
400 – 900 g.CO_2/kWh

Fuel Cell

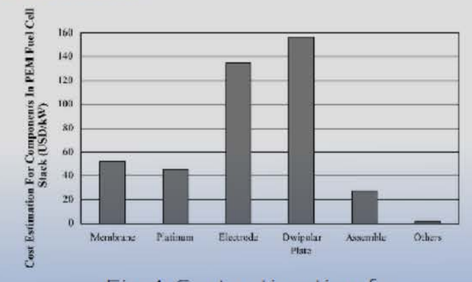


Fig 4. Cost estimation for components in fuel cell stack

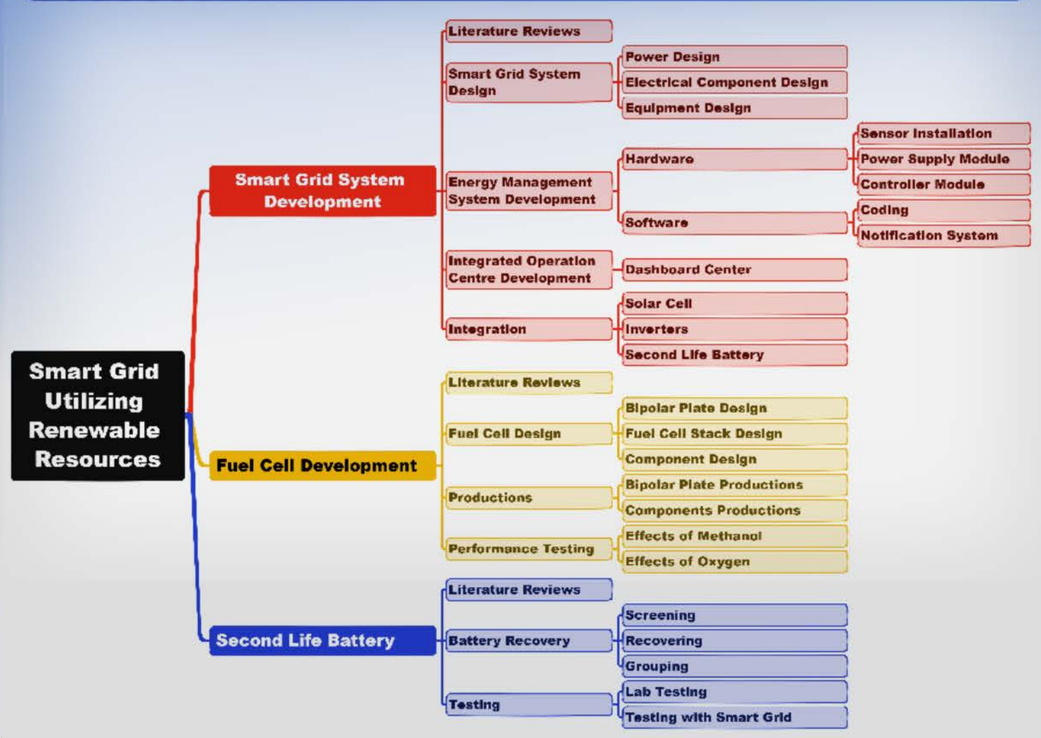
The **highest cost** within the stack pertains to the **bipolar plate**, accounting for **41%**

Second Life Battery

Fig 5. Battery demand

Increasing battery demand leads to more **battery waste**

Methods



Results & Discussions

Smart Grid System Development

Fig 6. Energy management system development

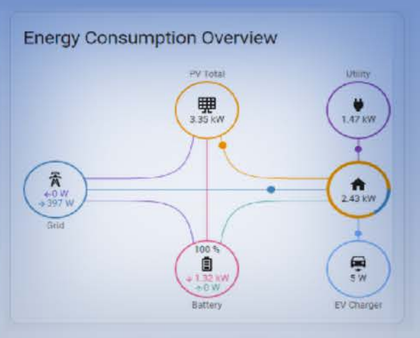


Fig 7. Data transmission from energy management system to IoC

"Prototypes of a smart grid incorporating diverse renewable sources, including **solar cell**, **fuel cell**, and **second-life batteries**, have been created. The Energy Management System (EMS) oversees **source selection**, **issue notifications**, displays **source statuses**, and calculates **CO_2 emissions**. EMS data is transmitted to the Integrated Operation Center (IoC) system for comprehensive smart grid control."

Fuel Cell Stack Development

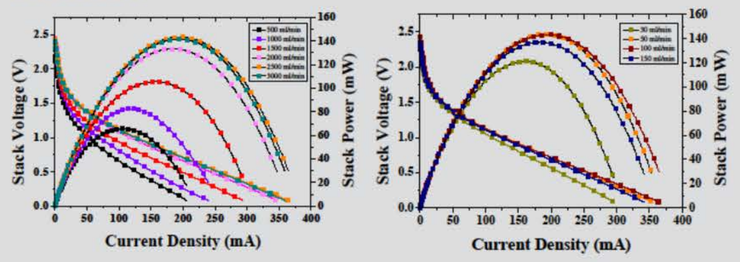
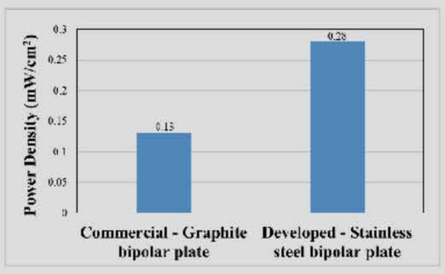


Fig 8. The performance of developed five cells DMFC stack with SSL bipolar plate (a) Effects of oxygen flowrate (b) Effects of methanol flowrate



"Developed fuel cell by changing the bipolar plate material to the stainless steel provided better performance, approximately **2.15** times than the commercial fuel cell."

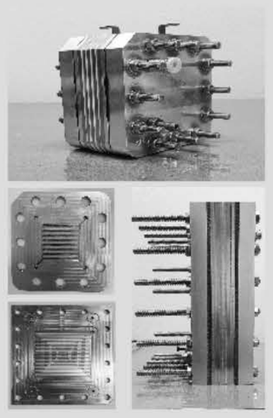


Fig 9. Comparative performance of commercial graphite and developed SSL bipolar plate

Second Life Battery as Energy Storage

Fig 10. Battery recovery process

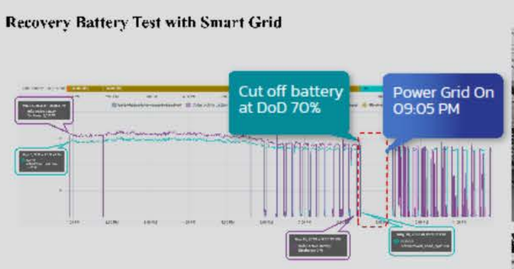


Fig 11. Recovered battery as energy storage testing with smart grid

"After usage, batteries can undergo a successful **recovery process**. when tested in a smart grid as an energy storage unit, the recovered batteries exhibited an energy of **10.64 kWh**."

Conclusions

In summary, our study introduces significant advancements in smart grid prototypes, integrating PV, fuel cells, and second-life batteries. The Energy Management System (EMS) efficiently handles source selection, issue notifications, status displays, and CO_2 emission calculations, enhancing overall smart grid control.

Transitioning to stainless steel bipolar plates in fuel cells produced a significant 2.15 times performance improvement compared to graphite commercial fuel cells. Under specific operational conditions with 5 cells testing, the maximum output at 142.87 mW, 0.70 V, and 194.18 mA.

Additionally, our study successfully demonstrated battery recovery processes. Tested as an energy storage unit in a smart grid, the recovered batteries showed an energy of 10.64 kWh.

These results contribute to carbon emissions reduction, optimized energy distribution, and enhanced grid efficiency and resilience.

Acknowledgements

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Bioplastic from Cassava Starch and Biomass

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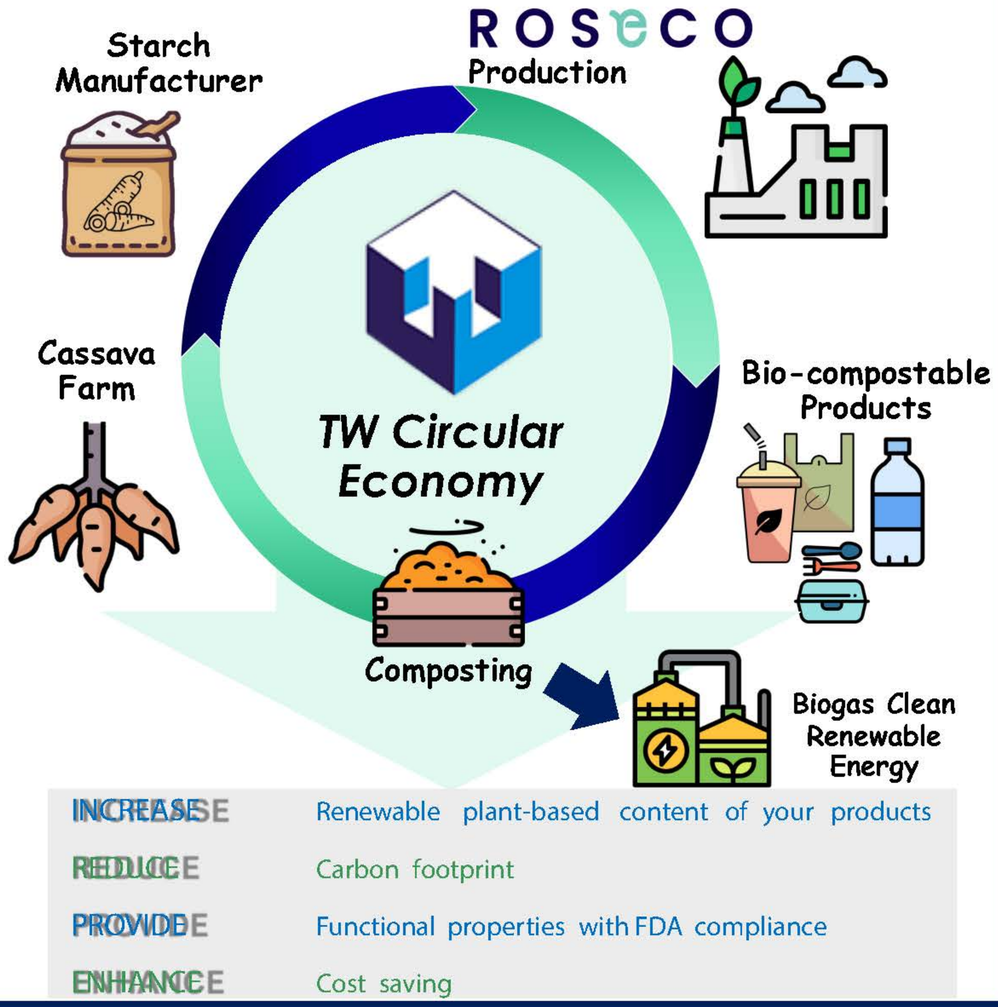
Center of Excellence on Petrochemical and Materials Technology (PETROMAT), Chulalongkorn University

Thai Wah Public Company Limited

INTRODUCTION



INCREASE	Renewable plant-based content of your products
REDUCE	Carbon footprint
PROVIDE	Functional properties with FDA compliance
ENHANCE	Cost saving

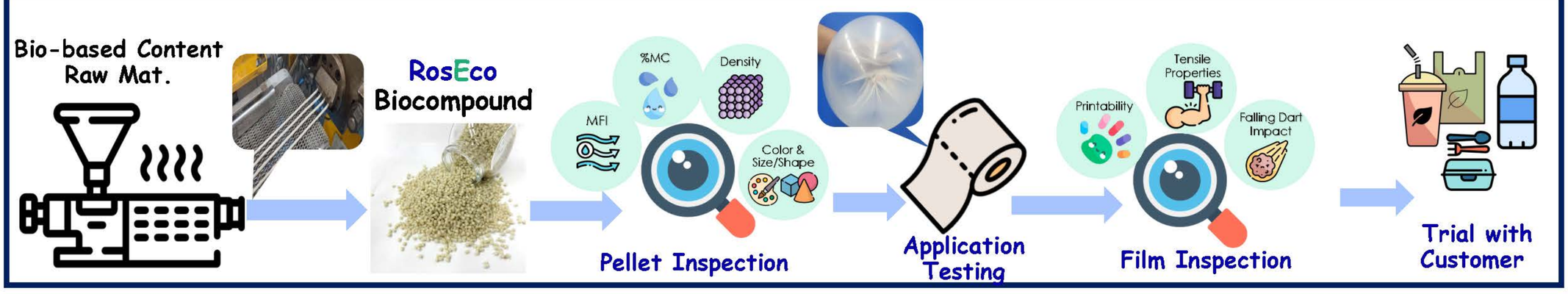
PURPOSE ON THIS WORK

1. Develop bioplastic from cassava starch and biomass
2. Study effects of bio-based content in bioplastic properties
3. Apply Roseco bioplastics for various applications

CONCLUSION

- Bioplastic resins with **20-70% bio-based content** were successfully synthesized from cassava starch and biomass.
- **Bio-based content plays an important role** in the properties of bioplastic.
  - **Improving mechanical properties** of film by increasing bio-based content
  - **Better printability** by adding biobased content
- Roseco bioplastic are available for **various applications** with high performance (e.g. Straw, Shopping Bag, Garbage Bag, etc.)

METHODS



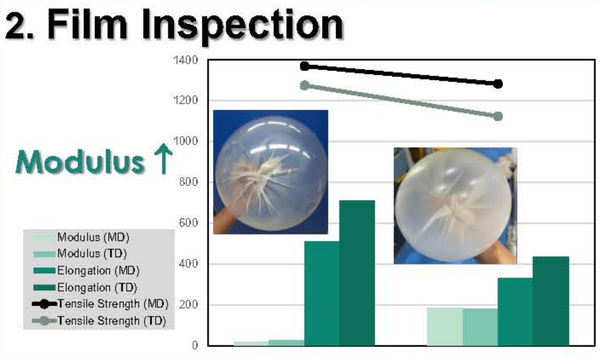
RESULTS & DISCUSSION

1. Pellet Inspection

Properties	Bioboost X1	Bioboost X2	Bioboost X3
Bio-based content (%)	20-30	40-50	60-70
MFI (g/10 min) Test Method; ASTM D1238 (190 °C, 2.16 kg)	4-6	1-3	6-10
Moisture Content (%) Test Method; ASTM D6980	0.3-0.4	0.4-0.5	1.0-1.1
Density (g/cm³) Test Method; ASTM D792	1.25-1.30	1.30-1.35	1.35-1.40

Stable process

2. Film Inspection

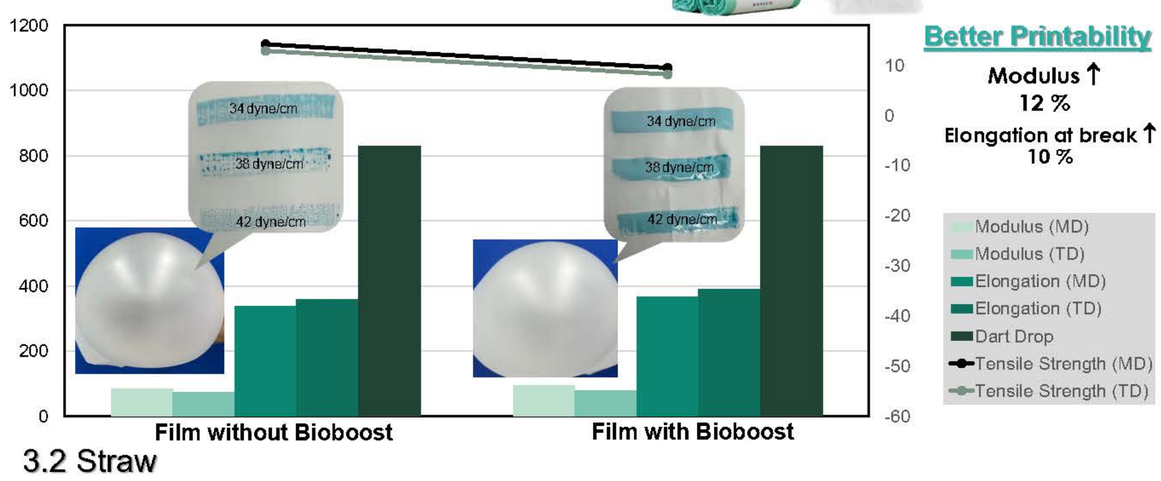


Properties		Bioboost X1	Bioboost X2
Modulus (MPa)	MD	>17	>180
	TD	>23	>180
Tensile Strength (MPa)	MD	>16	>13
	TD	>13	>9
Elongation at break (%)	MD	>510	>330
	TD	>710	>430

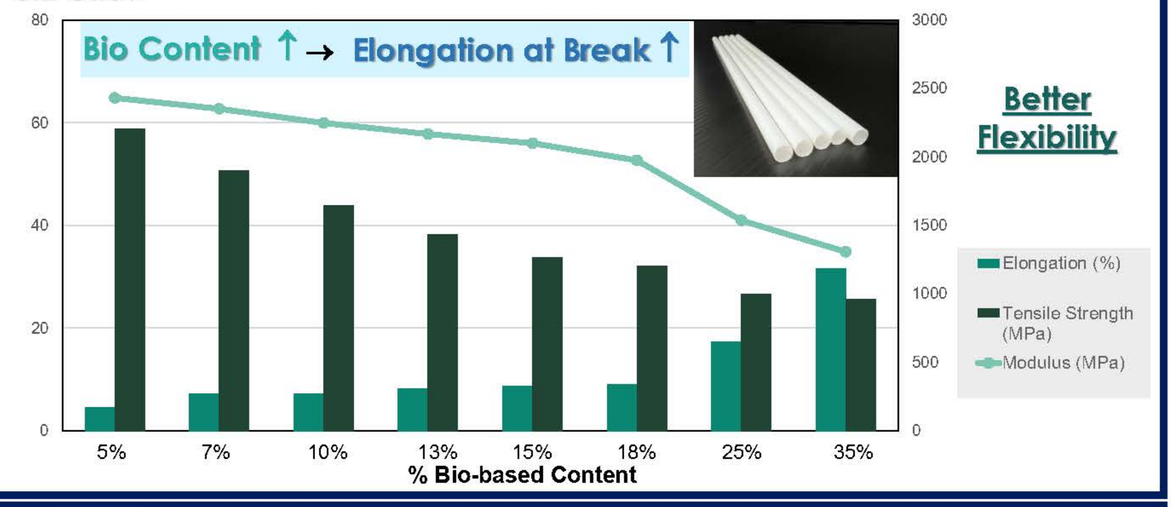
Stable process

3. Trial Results

3.1 Compostable Bag (e.g. Garbage Bag, Shopping Bag)



3.2 Straw



ACKNOWLEDGEMENTS

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สู่อุตสาหกรรมแห่งอนาคต

Development of Adsorbent-based CO_2 Capture System and Feasibility Study for Industrial Scale Application

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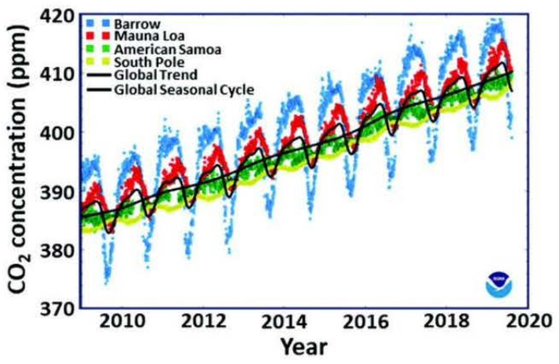
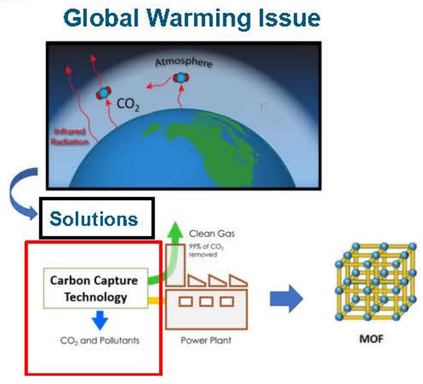
Principle investigator: Prof. Boonyarach Kitiyanan

Introduction

The recent concentration of CO_2 in the atmosphere



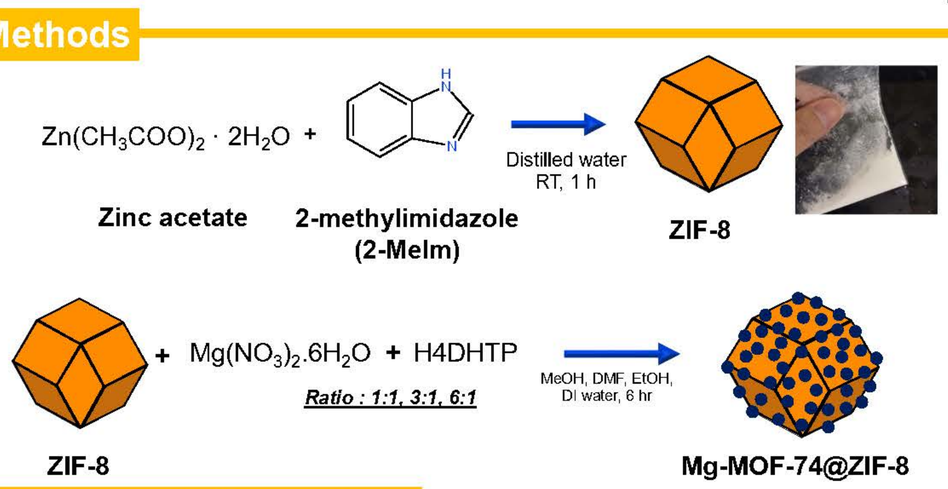
Global Warming Issue



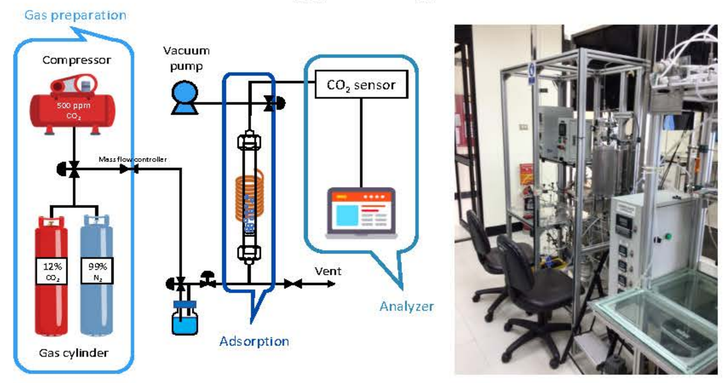
Global trend for the increase in CO_2 concentration in the last 10 years measured at different observatories contained in the Global Monitoring Division (GMD) of the Earth System Research Laboratory (ESRL). (http://esrl.noaa.gov/gmd/).

As atmospheric CO_2 concentrations surpassed 400 ppm in 2015, it became urgently necessary to mitigate greenhouse gas emissions, as carbon dioxide (CO_2) emissions are the primary cause of global warming. Post-combustion, pre-combustion, oxy-combustion, and direct air capture are a few of the numerous techniques involved in lowering ambient CO_2 concentration and carbon emissions. With respect to effectively mitigating elevated atmospheric CO_2 concentrations, Carbon capture or Direct air capture (DAC), specifically, is still in its early stages of development but exhibits potential. Additional carbon capture processes, including the extraction of CO_2 from fuel gases, natural gas, and biogas, may be facilitated by materials produced through the efficient implementation of DAC. A consequence of the extensive coordination bonds that form between metal cations and organic ligands, metal-organic frameworks (MOFs) are regarded as the future of adsorbent materials. MOFs are distinguished from conventional adsorbents by their remarkable porosity and surface area, ability to be modified in terms of pore size and structure, and flexible structure when it comes to undergoing various changes. In addition to gas separation, heterogeneous catalysis, water purification, and biomedical applications, these exceptional characteristics render them exceedingly promising for a wide range of uses.

Methods

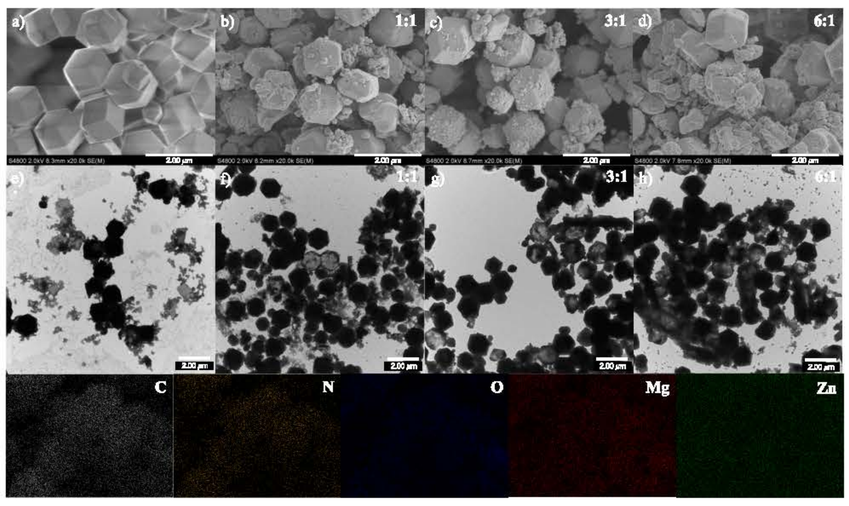


Technology Background



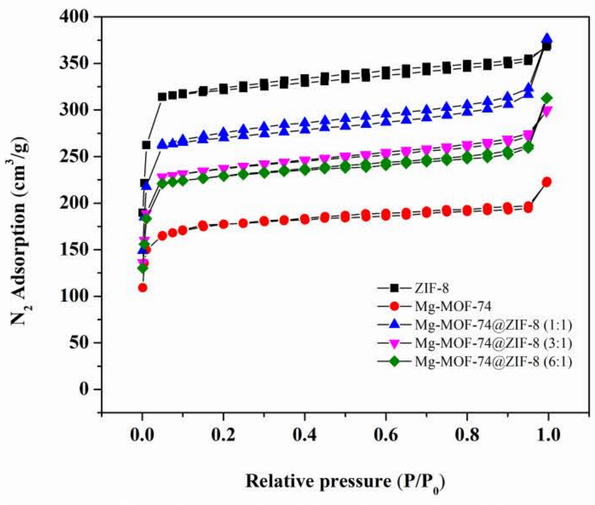
Results and Discussions

❑ *Mg-MOF-74@ZIF-8 structure*



- The formation of Mg-MOF-74@ZIF-8 structure has no impact on the morphology and size of the crystal, with the exception of its outer layer, which exhibits a non-smooth texture, leading to the presence of many crystal defects.

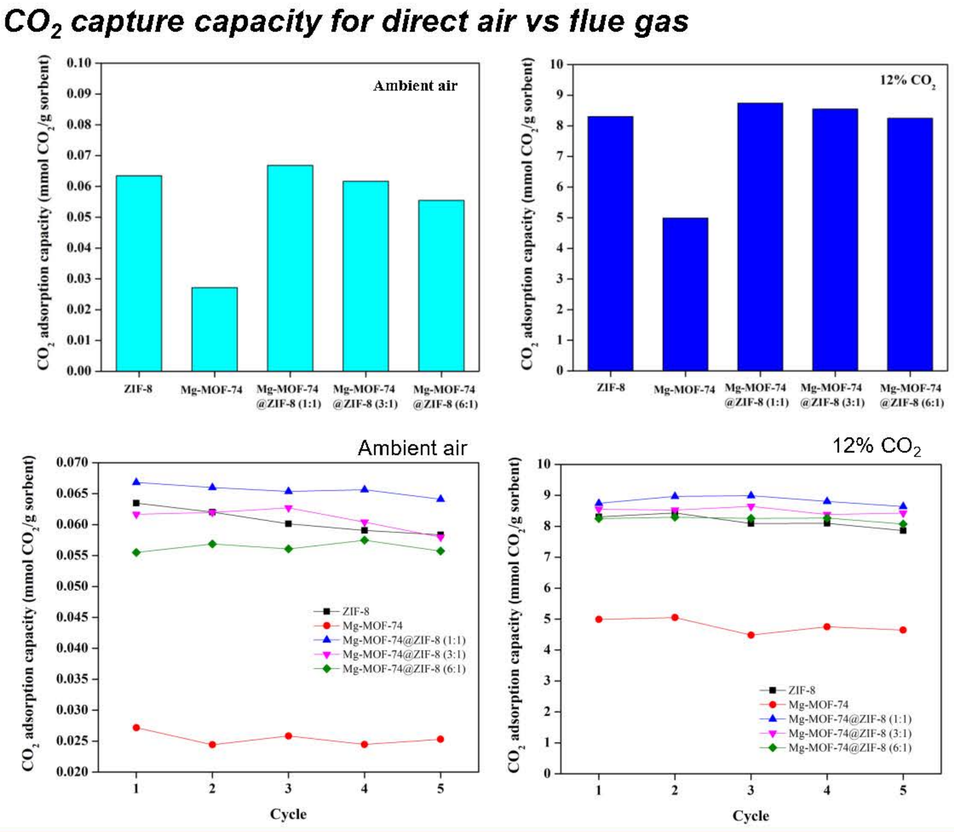
❑ *Textural parameters of Mg-MOF-74@ZIF-8 structure*



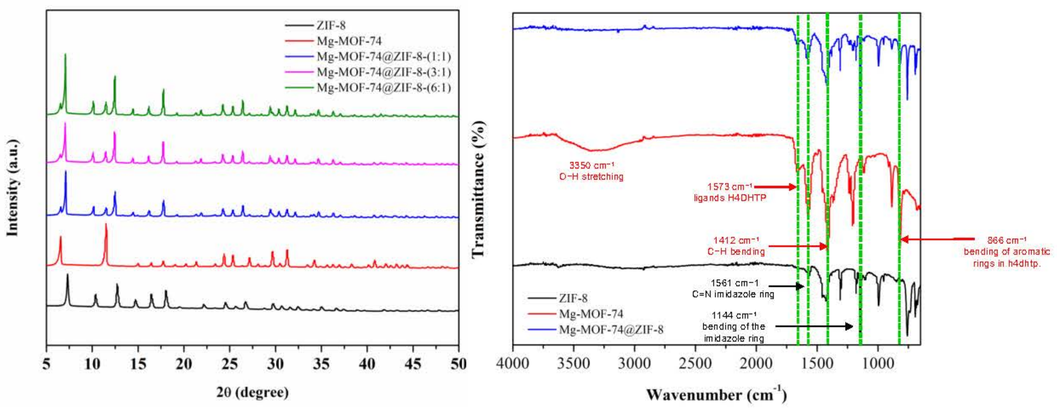
MOFs	BET surface area (m^2/g)	Pore volume (cm^3/g)	Pore diameter (nm)
ZIF-8	975.45	0.72	0.90
Mg-MOF-74	136.87	0.25	0.79
Mg-MOF-74@ZIF-8 (1:1)	823.61	0.76	0.90
Mg-MOF-74@ZIF-8 (3:1)	765.50	0.63	0.89
Mg-MOF-74@ZIF-8 (6:1)	699.32	0.61	0.90

- Mg-MOF-74@ZIF-8 crystals are typical type-I profile according to the IUPAC classification of the adsorption isotherms, representing their microporous structure. Indeed, the microporous materials provide outstanding specific surface area for gas adsorption, owing to their high surface to volume ratio.

❑ *CO_2 capture capacity for direct air vs flue gas*



❑ *XRD and chemical functional group*



- The formation of composite Mg-MOF-74@ZIF-8 structure can be confirmed through comparison of its XRD pattern. It can be seen that the XRD pattern of Mg-MOF-74@ZIF-8 was consistent with the pristine ZIF-8 and Mg-MOF-74 indicating the successful formation of the outer layer on the core MOF.
- The spectrum of composite MOFs can be found in Mg-MOF-74-@ZIF-8, which provides strong evidence for the presence of both ZIF-8 and Mg-MOF-74 within the structure of the composite material.

Acknowledgments

- This research has received funding support from the NSRF via the Program Management Unit for Human Resources and Institutional Development, Research and Innovation [grant number B01F650006]
- Nagase (Thailand) Co.,Ltd has provided funding and support for this researches

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GEOPOLYMER/ZEOLITE COMPOSITE FOR EFFICIENT REMOVAL OF AZO DYE FROM AQUEOUS SOLUTIONS: SYNTHESIS, CHARACTERIZATION AND ADSORPTION PROCESS OPTIMIZATION

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1. Objective Proposed Work

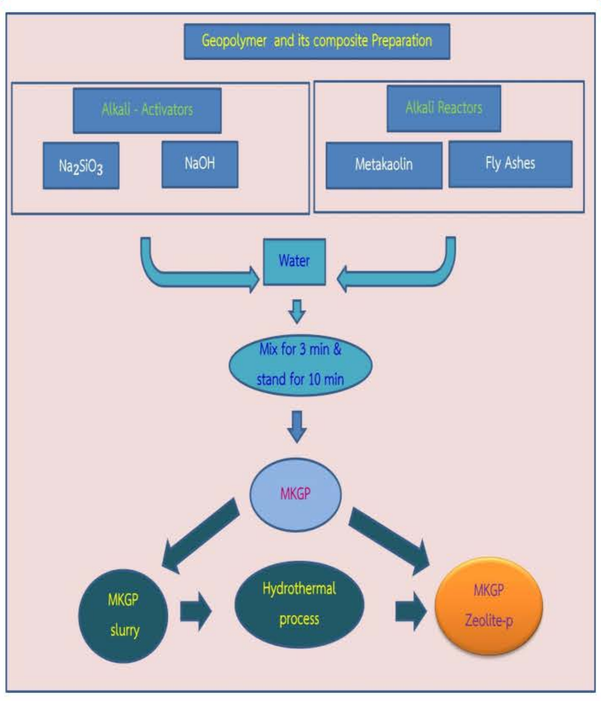
- To develop a geopolymer/zeolite-P composites for methyl orange dye removal .
- To assess the mechanical properties, dye adsorption of the geopolymer/zeolite-P composites.
- To study the development of structural, physical and chemical properties of different materials in geopolymer composites.

2. Introduction

- In today's changing environment, due to various reasons such as population growth, industrialization, urbanization, the demand of dyes is escalating that causes various negative effects on life.
- Scientists are making various efforts to control this impact, especially for dye removal using adsorption method.
- Our research group aims to prepare geopolymer/zeolite-P composite materials made from combustion by-products for dye adsorption.

3. Graphical abstract

4. Materials and Methods



5. Results and Discussions

5.1. X-Ray Diffraction Analysis

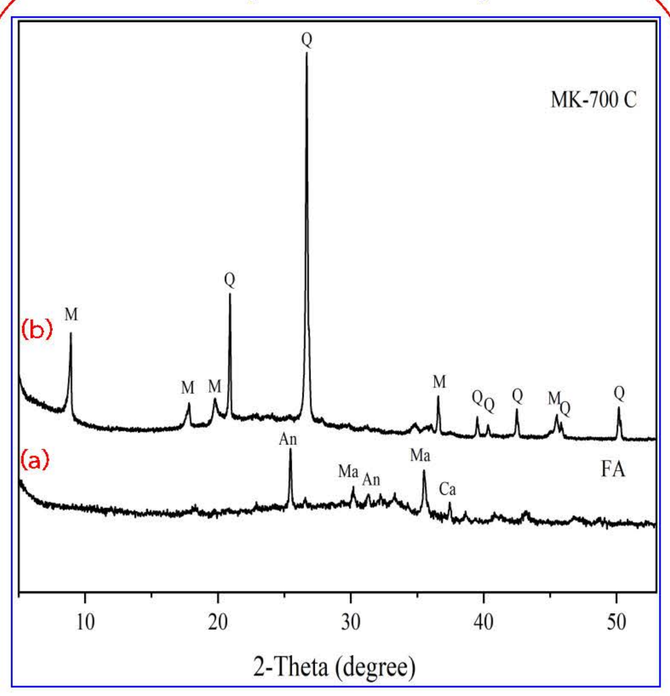


Fig. 2 XRD pattern of (a) FA and (b) MK

5.2 Scanning Electron Microscopy Analysis

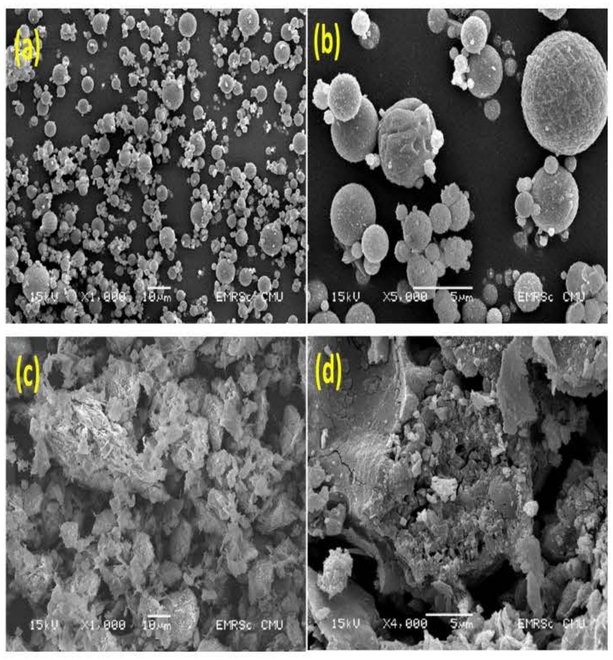


Fig. 3. SEM images of (a-b) FA, (c-d) MK at different magnifications

Table : 1 Chemical composition of raw materials by XRF

Chemical composition (wt. %)	Al_2O_3	SiO_2	Fe_2O_3	CaO	SO_3	MgO	K_2O	TiO_2	P_2O_5	Sum
FA	17.13	28.28	18.06	24.87	05.21	03.56	02.18	00.41	0.30	89.41
Kaolinite	33.11	58.57	01.61	0.03	0.00	0.07	01.75	0.09	0.04	95.27
MK	39.98	55.31	02.03	0.08	0.04	0.29	02.04	0.12	0.09	99.98

Table : 2 Particle size and BET surface area and ICP-OES (mg/L) of FA, and MK

Raw materials		Fly ash	Metakaolin	Metakaolin milled 12 h
Particle size distribution ($D_{0,5}$) (μm)		11.12	19.39	7.76
BET(m^2/g)		9.59	29.82	13.40
ICP-OES (mg/L)	Si^{4+}	56.6	205	211
	Al^{3+}	18.7	144	144

6. Conclusions

- A different types of **geopolymer/zeolite-P composites** based on combustion by-product and metakaolin will be successfully prepared by geopolymerization and **hydrothermal process** for methyl orange dye degradation in the near future.
- The composites will be successfully formed by hydrothermal methods and their chemical and physical properties will demonstrated by **XRD, SEM, BET, compressive strength, cation exchange capacity** analysis etc.
- Adsorption capacity will be checked with **pH value, time, adsorbent dosage and dye concentration.**
- Our research group is **investigating to find out which compound** has the highest adsorption capacity to remove the azo dyes from the simulated **wastewater.**

Acknowledgement

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The authors would like to acknowledge Research & Innovation Center, SCG Cement Co., Ltd. for research collaboration and financial support.