UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF SUPPORTED NICKEL-BASED CATALYSTS FOR DEOXYGENATION OF WASTE COOKING OIL TO RENEWABLE FUEL PRODUCTION

WAN NOR ADIRA BINTI WAN KHALIT

FS 2022 43

DEVELOPMENT OF SUPPORTED NICKEL-BASED CATALYSTS FOR DEOXYGENATION OF WASTE COOKING OIL TO RENEWABLE FUEL PRODUCTION

By

WAN NOR ADIRA BINTI WAN KHALIT

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

March 2022

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

DEVELOPMENT OF SUPPORTED NICKEL-BASED CATALYSTS FOR DEOXYGENATION OF WASTE COOKING OIL TO RENEWABLE FUEL PRODUCTION

By

WAN NOR ADIRA BINTI WAN KHALIT

March 2022

Chair : Professor Datuk ChM. Ts. Taufiq Yap Yun Hin, PhD
Faculty : Science

The development of renewable diesel fuel from the deoxygenation of non-edible oil is an alternative to non-renewable fuels. This study investigated the catalytic deoxygenation of waste cooking oil (WCO) over supported Ni-based catalysts. The deoxygenation of WCO was conducted using different types of supports: activated carbon (AC), reduced graphene oxide (rGO), and beta zeolite (Zeo). The addition of Ni to AC improves the physicochemical properties of the catalyst, owing to the high number of acid-base sites, high surface area, smaller crystallite size, and high pore volume of the catalyst. Based on the catalytic results, Ni_{20}/AC was the most active catalyst, which achieved 90% hydrocarbon yield and 89% selectivity towards *n*-(C_{15}+C_{17}). Furthermore, it was stable up to the fourth cycle with consistent hydrocarbon yield (85-87%) and 66-77% selectively towards *n*-(C_{15}+C_{17}). Further investigation was conducted to study the effect of bifunctional catalysts (NiLa, NiCe, NiFe, NiMn, NiZn, and NiW) supported on AC. High hydrocarbon yield above 60% with lower oxygenated species was found in the liquid product with the product selectively toward *n*-(C_{15}+C_{17})-diesel fractions. The predominance of *n*-(C_{15}+C_{17}) hydrocarbons with concurrent production of CO and CO_2 indicated that the deoxygenation pathway preceded via decarbonylation and decarboxylation mechanisms. For NiLa/AC, high deoxygenation activity with better *n*-(C_{15}+C_{17}) selectivity was obtained due to great synergistic interaction between La–Ni, and its compatibility of acid-base sites increased the removal of oxygenates. For the effect of La on the deoxygenation performance, it was found that a high percentage of La species would be beneficial in the removal of C-O bonded species. Furthermore, optimum deoxygenation activity of 88% hydrocarbon yield with 75% *n*-(C_{15}+C_{17}) selectivity was obtained over 20% La, which strongly evinced that La leads to more significant enhancement of deoxygenation activity. The NiLa/AC reusability study showed consistent deoxygenation with 80% hydrocarbon yield and 60% *n*-(C_{15}+C_{17}) hydrocarbons selectivity within six runs. As the NiZn/AC catalyst also showed high performance in deoxygenation activity, the optimization over a series of $Ni_{20}Zn_x$/AC catalysts (X: 5–20 wt.%) was also studied. The $Ni_{20}Zn_{10}$/AC catalyst exhibited superior deoxygenation activity by yielding 86% hydrocarbons and 79% of *n*-(C_{15} + C_{17})

selectivity. High deoxygenation activity is corroborated by the higher acidity and basicity strength of the catalyst and the oxygenate species removal that occurred via decarbonylation pathway. The $Ni_{20}Zn_{10}$/AC catalyst showed promising catalytic stability and reusability up to four runs with hydrocarbon yield (78 – 87%) and *n*-(C_{15} + C_{17}) selectivity within the range of 43 – 70%, respectively. The decrease in the *n*-(C_{15} + C_{17}) selectivity in the fourth cycle was due to the active metal species leaching and coking. In conclusion, all Ni-based catalysts demonstrated significant catalytic activity and reusability for green diesel production.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PEMBANGUNAN MANGKIN BERASASKAN NIKEL YANG DISOKONG UNTUK PENYAHOKSIGENAN SISA MINYAK MASAK KEPADA PENGHASILAN BAHAN API YANG BOLEH DIPERBAHARUI

Oleh

WAN NOR ADIRA BINTI WAN KHALIT

Mac 2022

Pengerusi : Profesor Datuk ChM. Ts. Taufiq Yap Yun Hin, PhD
Fakulti : Sains

Pembangunan bahan bakar diesel yang boleh diperbaharui melalui penyahoksigenan minyak yang tidak boleh di makan merupakan satu alternatif kepada bahan bakar yang tidak boleh diperbaharui. Kajian ini menyiasat penyahoksigenan pemangkin bagi sisa minyak masak (WCO) menggunakan pemangkin berasaskan Ni. Tindak balas penyahoksigenan terhadap WCO dilakukan menggunakan pelbagai jenis sokongan: karbon teraktif (AC), grafena oksida yang dikurangkan (rGO) dan beta zeolit (Zeo). Penambahan Ni ke AC meningkatkan sifat fizikokimia pemangkin yang baik disebabkan oleh bilangan tapak asid-bes yang tinggi, luas permukaan yag tinggi, saiz kristal yang lebih kecil dan jumlah liang pemangkin yang tinggi. Dari hasil penyahoksigenan, Ni_{20}/AC menunjukkan pemangkin paling aktif dengan memberikan 90% hasil hidrokarbon dan 89% pemilihan *n*-(C_{15}+C_{17}). Tambahan pula, pemangkin tersebut menujukkan kestabilan sehingga kitaran keempat dengan hasil hidrokarbon yang konsisten (85-87%) dan pemilihan *n*-(C_{15}+C_{17}) (66-77%). Penye1idikan lebih lanjut dilakukan untuk mengkaji kesan pemangkin dwifungsi (NiLa, NiCe, NiFe, MiMn, NiZn, dan NiW) yang disokong pada AC. Hasil hidrokarbon melebihi 60% dengan spesies oksigen yang lebih rendah didapati dalam produk cecair dengan pemilihan utama terhadap *n*-(C_{15}+C_{17})-pecahan diesel. Penguasaan hidrokarbon *n*-(C_{15}+C_{17}) dengan pengeluaran CO dan CO_2 secara serentak menunjukkan bahawa penyahoksigenan melalui tindak balas penyahkarbonilan dan penyahkarbosilan. Penyahoksigenan aktiviti yang tinggi dan pemilihan *n*-(C_{15}+C_{17}) yang lebih baik oleh pemangkin NiLa/AC disebabkan oleh interaksi sinergistik yang baik antara La–Ni, dan keserasian tapak-tapak asid dan bes meningkatkan lagi penyingkiran spesis oksigen. Kajian mengenai kesan La terhadap penyahoksigenan aktiviti dijalankan dan mendapati bahawa peratusan spesis La yang tinggi bermanfaat untuk penyingkiran spesis terikat C–O. Di samping itu, 20% La menunjukkan optimum penyahoksigenan aktiviti dengan menghasilkan 88% hasil hidrokarbon and 75% pemilihan *n*-(C_{15}+C_{17}), yang membuktikan bahawa La membawa kepada peningkatan penyahoksigenan aktiviti yang lebih ketara. Kajian kebolehgunaan semula NiLa/AC menunjukkan tindak balas penyahoksigenan yang stabil dengan hasil hidrokarbon 80% dan pemilihan *n*-(C_{15}+C_{17}) 60% dalam enam kitaran. Oleh kerana

pemangkin NiZn/AC juga menunjukkan penyahoksigenan aktiviti yang tinggi maka pengoptimuman terhadap satu siri pemangkin $Ni_{20}Zn_x$ / AC (X: 5-20 wt.%) juga dijalankan. Pemangkin $Ni_{20}Zn_{10}$/AC menunjukkan penyahoksigenan aktiviti yang tinggi dengan menghasilkan 86% hidrokarbon dan 79% pemilihan *n*-(C_{15}+C_{17}). Aktiviti penyahoksigenan yang tinggi disebabkan oleh kekuatan asid dan bes pemangkin dan penyingkiran spesis oksigen berlaku melalui tindak balas penyahkarbonilan. Diperhatikan, pemangkin $Ni_{20}Zn_{10}$/AC menunjukkan penyahoksigenan aktiviti yang stabil dan penggunaan semula pemangkin sehingga empat kitaran dengan hasil hidrokarbon (78-87%) dan pemilihan *n*-(C_{15}+C_{17}) (43-70%). Penurunan pemilihan *n*-(C_{15}+C_{17}) adalah disebabkan oleh pelarutlesapan tapak aktif logam dan pembentukan karbon. Kesimpulannya, semua pemangkin berasaskan Ni menunjukkan aktiviti pemangkinan dan penggunaan semula yang ketara untuk pengeluaran diesel hijau.

ACKNOWLEDGEMENTS

First of all, I commend the Almighty Allah S.W.T. for giving me great strength and courage to overcome so many hardships in successfully conducting and completing this research.

My deepest gratitude goes to my supervisor, Professor Datuk Dr Chm. Ts. Taufiq Yap Yun Hin, and my co-supervisors, Dr Tengku Sharifah Marliza Tengku Azmi and Dr Mohd Izham Saiman, for their encouragement, advice, guidance, and support throughout my research journey. I am sincerely grateful to them for their contribution in terms of time, patience, and commitment. Additionally, I would like to extend my warmest respect and appreciation to Dr Nurul Asikin Mijan and all my colleagues at PutraCAT. Their advice, feedback, and encouragement are indeed respected.

Moreover, not forgetting to my beloved husband, Mohamad Haiqal bin Mazlan and my son, Mohamad Ali Imran bin Mohamad Haiqal and my family members who have always given me courage and inspiration, and support for my studies. Their love, prayers, and understanding constantly encourage me to complete my research. Throughout my research journey, I would like to dedicate my gratitude and appreciation to all my friends for their support and help, either directly or indirectly.

Finally and most importantly, the financial support from Skim Latihan Akademik Bumiputra (SLAB) and Tenaga Akademik Muda (TAM) from Universiti Putra Malaysia are gratefully acknowledged and appreciated.

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

Taufiq Yap Yun Hin, PhD
Professor Datuk ChM. Ts.
Faculty of Science
Universiti Putra Malaysia
(Chairman)

Mohd Izham bin Saiman, PhD
Senior Lecturer
Faculty of Sciences
Universiti Putra Malaysia
(Member)

Tengku Sharifah Marliza binti Tengku Azmi, PhD
Senior Lecturer
Faculty of Humanities, Management, and Science
Universiti Putra Malaysia Bintulu Campus
(Member)

_____
ZALILAH MOHD SHARIFF, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 8 September 2022

Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

Signature	: _____
Name of Chairman of Supervisory Committee	: Taufiq Yap Yun Hin
Signature	: _____
Name of Member of Supervisory Committee	: Mohd Izham bin Saiman
Signature	: _____
Name of Member of Supervisory Committee	:Tengku Sharifah Marliza binti Tengku Azmi

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

OVAT	One variable at a time
ASTM	American Society for Testing and Materials
AOCS	American Oil Chemists' Society
JCPDS	Joint Committee on Powder Diffraction Standard
BET	Brunauer-Emmett-Teller
BJH	Barrett-Joyner-Halenda
TPD-NH_3	Temperature Programmed Desorption - ammonia
TPD-CO_2	Temperature Programmed Desorption - carbon dioxide
TCD	Thermal Conductivity Detector
FESEM	Fields Emission Scanning Electron Microscopy
EDX	Energy Dispersive X-ray
GC-FID	Gas Chromatography-Flame Ionization Detector
GC-MS	Gas Chromatography-Mass Spectrometry
FTIR	Fourier Transform Infrared Spectrometry
CHNOS	Carbon, Hydrogen, Nitrogen, Oxygen, and Sulphur
IUPAC	International Union of Pure and Applied Chemistry

CHAPTER 1

INTRODUCTION

1.1 Research Background

Global population growth causes rapid industrialisation, expanding urbanisation, and an increase in the number of transportations, resulting in increased global energy consumption. According to the US Energy Information Administration. global energy consumption is expected to increase by 50% between 2010 and 2050, (Sourmehi, 2021). Currently, fossil fuels meet the majority of energy demand, with oils, coal, and natural gas accounting for 33%, 27%, and 24%, respectively (Gross, 2020; Looney, 2020). However, these are not considered renewable energy sources because their applications are unfavourable from a financial, environmental, and ecological standpoint.

The transportation sector is essential to globalisation and contributes significantly to the economy. The primary sources of transportation energy use worldwide are gasoline and diesel. Global transportation fuel demand is relatively high, with approximately 4.9 billion L of gasoline and diesel consumed daily (Kalghatgi, 2019). Unfortunately, this consumes most fossil fuels, negatively affecting the living environment. The world's fossil fuel reserves are also rapidly depleting (Pattanaik & Misra, 2017). One of the most severe problems caused by fossil fuels is the massive emission of greenhouse gases (GHGs) that contribute to global warming.

According to the Inventory of U.S. Greenhouse Gas Emissions and Sinks (2021), carbon dioxide (CO_2) accounted for 80% of GHG emissions in 2019, followed by methane (10%), nitrous oxide (7%), and fluorinated gases (3%) (Figure 1.1a). Transportation was the leading source of GHG emissions (29%), followed by electricity (25%), industry (23%), commercial and residential (13%), and agriculture (10%) (Figure 1.1b). Researchers worldwide are concerned about the rapid increase in CO_2 emissions from transportation. One of the primary reasons for over 1.2 billion passenger cars worldwide is the proliferation of automobiles (Kalghatgi, 2018). According to the ITF Transport Outlook, (2019), global transportation demand is expected to triple by 2050.

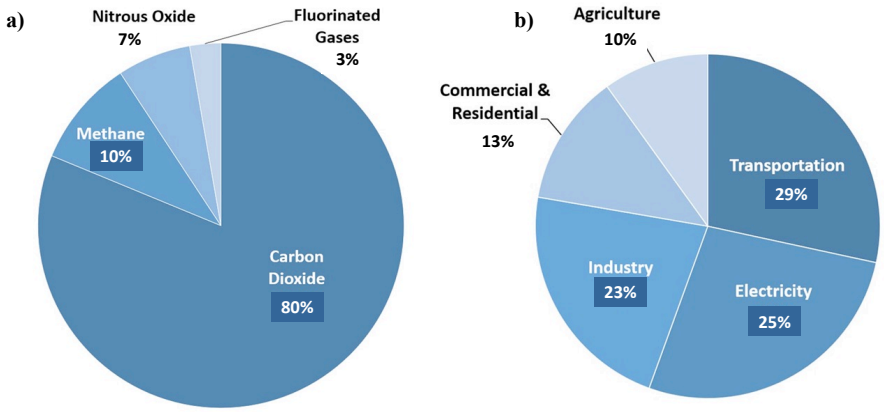

Figure 1.1: Overview of (a) GHGs emission and (b) sources of GHGs in 2019
[Adapted from Inventory of U.S. Greenhouse Gas Emissions and Sinks (2021)]

A substancial amount is consumed from various fossil fuel resources to meet this energy demand. Unfortunately, current consumption rates will deplete crude oil and natural gas reserves in 33 and 41 years, respectively. Every year, we consume approximately 11 billion tonnes of oil. However, crude oil reserves are depleted at a rate of 4 billion tonnes per year. If current trends continue, oil reserves will be depleted by 2051.

Nonetheless, if increased gas production can fill the energy gap left by oil, those reserves will last an additional eight years until 2061. Even though the world has enough coal reserves to last until the end of the century, increased production is needed to fill the void left by the depletion of oil and gas reserves. Coal reserves will supply enough energy until 2088. Even so, the global energy consumption rate is not constant because it grows significantly with the global population and improved living standards. Furthermore, the world is on the verge of an energy crisis, prompting researchers to investigate alternative approaches. Figure 1.2 depicts the world's coal, oil and gas energy reserves and the point at which fossil fuels may be depleted in the future.

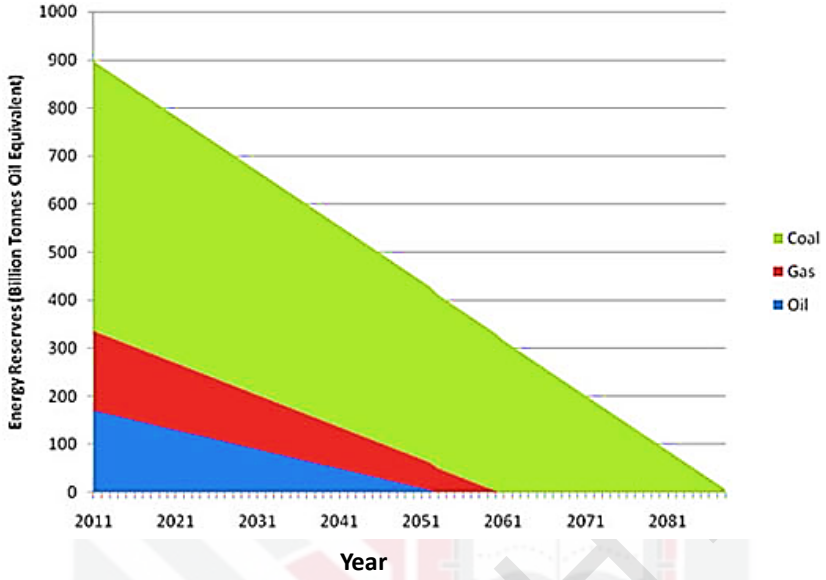

Figure 1.2: Energy reserves for coal, gas, and oil in the future (Kuo, 2019)

1.2 Renewable Energy

Using renewable energy resources to replace fossil fuels would reduce GHG emissions and make renewable energy more appealing. Renewable energy is considered "green" and is one of the environmentally friendly energies that never run out and can be used without reducing its future availability. Hydropower, solar energy, geothermal, wind energy, marine energy, and biomass energy are the primary sources of renewable energy (Pattanaik & Misra, 2017). Currently, the primary focus of renewable energy research is on biomass energy. Agriculture crop residue, forestry, food processing, and animal fats are all biomass sources. Waste vegetable oils and animal fats have been targeted as a renewable feedstock for biofuel production (Kordulis et al., 2016).

Figure 1.3 depicts global energy consumption by energy sources in 2020. Renewable energy accounts for 12% of global energy consumption. Biomass energy (39%) is one of the most important renewable energy sources. Renewable energy, such as biofuels, can improve energy security while reducing GHG emissions and preventing air pollution. Future generations will benefit from a cleaner environment, a more stable economy, and a more reliable energy source as more renewable resources are used. According to Baležentis et al. (2019), a 1% increase in biomass energy output results in a 0.089% reduction in GHG emissions.

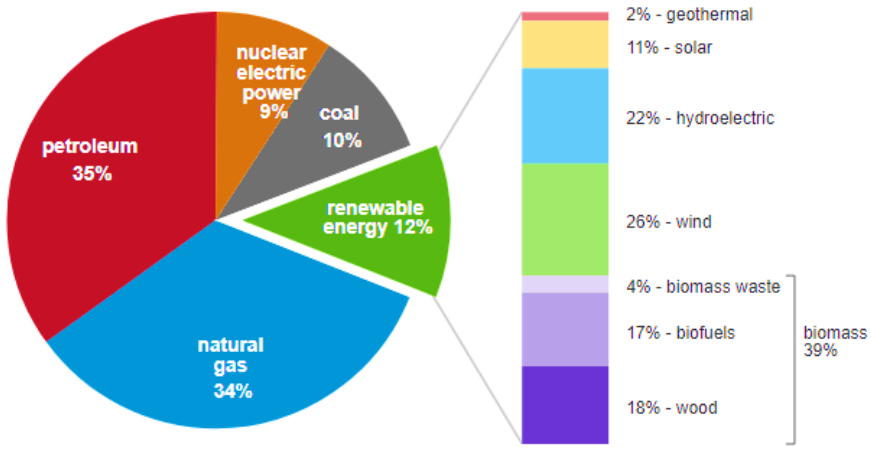

Figure 1.3: Global energy consumption by energy sources in 2020 [Adapted from U. S. Energy Information Administration (2021)]

1.3 Biofuels as a Petroleum Alternative

Biofuels are liquid or gaseous fuels derived from biomass such as corn starch, vegetable oils, animal fats, sugarcane, grasses, or trees. Biofuels are the only viable alternatives to petroleum because they have the potential for large-scale production due to the abundance of biomass sources. Furthermore biofuels are biodegradable and contribute to environmental sustainability. Pyrolysis, gasification, and chemical and biochemical processes are all methods for producing biofuel from biomass. Syngas (CO and H_2) is produced by pyrolysis and gasification and is converted to hydrocarbons for use as fuels. Chemical processing of biomass yields biofuels via homogeneous or heterogeneous catalysis, whereas biological processes (for example, biomass fermentation) use enzymatic catalysis.

Green fuel is a biofuel that includes green gasoline (C_8-C_{14}) and green diesel (C_{15}-C_{18}) that contain *n*-alkane and *n*-alkene hydrocarbons. The green fuel obtained is similar to gasoline and diesel from crude oil refining in petroleum refineries. Green diesel production is a simple, cost-effective, and low polluting process. Deoxygenation is the most effective method for producing green diesel from biomass when heterogeneous catalysts are used. Furthermore, green diesel, which has a higher heating value, energy density, cetane number, and quality than diesel fuel, was recently named the most preferred biofuel.

1.4 Problem Statement

Excessive waste cooking oil (WCO) production has become a major global issue. Improper WCO handling may stimulate the production of organic contaminants in land and water, contributing to environmental pollution. The proper recycling of WCO through conversion to industrial products such as green diesel is an ideal solution. WCO can be used directly in a diesel engine. However, there are several disadvantages to using WCO directly including high viscosity, low volatility, and engine problems such as coking on injectors, carbon deposition, and lubricating oil thickening (Biswas et al., 2017). As a result, WCO must be upgraded to be used as green diesel. Due to its similar diesel-fuel properties, high cetane number, and high calorific value producing green diesel using hydroprocessing technologies is a potential process for producing diesel-like hydrocarbon (Gamal et al., 2020).

Hydroprocessing technology (e.g., hydrodeoxygenation) is preferred in the refinery industry. Adding H_2 results in forming hydrocarbons in the C_{15} - C_{18} range and removing O_2 as a by-product in the form of H_2O. However, due to the high cost of H_2 consumption, hydrodeoxygenation is less desirable method of producing green diesel. As a result, the production of green diesel via deoxygenation has been implemented, with the reaction taking place in an H_2-free environment.

However, current deoxygenation research is more focused on using noble metals (such as Pt and Pd) and sulfided metals (such as ReNiMoS, NiMoS, CoMoS, and NiWS) as catalysts (Lup et al., 2017a). These active metals have been proven to be the most effective catalysts. Nonetheless, due to the high cost of noble metals, large-scale green diesel production is limited, and sulphur leaching from sulfided catalysts has the potential to contaminate green diesel quality (Ramesh et al., 2020). Hence, research has focused on developing low-cost and sulfur-free catalysts. The transition Ni approximately 1750 and 3450 times less expensive than the noble metals Pd and Pt (Asikin-Mijan et al., 2018; Santillan-Jimenez et al., 2013).

In addition, Ni-based catalysts also outperformed numerous noble-metal catalysts (Hongloi et al., 2021). Thus, transition metal oxides (TMO) are more suitable for deoxygenation. Ni-based catalysts have been studied to improve deoxygenation activity among various TMO catalysts. This is due to the high reactivity of Ni-based catalysts in converting triglycerides-based biomass to primary products in the diesel-range hydrocarbon. On the other hand, it has been proposed that the primary role of Ni-based catalysts is to promote C–C and C–O breakage via decarboxylation/decarbonylation pathways. Evidently, a $60Ni/Al_2O_3$ catalyst was effectively upgraded the triglycerides in sunflower oil to green diesel with 96% conversion to hydrocarbon and 52% to *n*-C_{17} selectivity (Gousi et al., 2017).

Nevertheless, in the deoxygenation of soybean oil, a 20 wt.% Ni/C catalyst also showed a greater conversion to hydrocarbon (92%) followed by 5 wt.% Pd/C (30%) and 1 wt.% Pt/C (23%) (Morgan et al., 2010). Previously, the deoxygenation of triolein over Ni/HMS catalyst was capable of inducing the C–C cleavage and C–O cleavage and resulted in a

higher selectivity towards diesel-range (C_{11}-C_{20}) (95%) (Zulkepli et al., 2018). The acidic sites of the Ni-based catalysts is also responsible for effectively removing oxygenating species in deoxygenation reaction.

Furthermore, larger pore diameters of catalysts may make waste oil molecules more easily transported to active catalytic sites, thus increasing deoxygenation activity. The nature of the reactant, on the other hand, has minimal effect on the activity of Ni-based catalysts. As a result, Ni-based catalysts are considered suitable for a wide range of reactants in the production of green diesel, particularly in WCO.

Catalyst supports are also crucial in increasing deoxygenation activity. Carbon-based support effectively promotes the deoxygenation of fatty acid and their derivatives. Activated carbon (AC) also has a large surface area due to its microporous structure, which contains numerous functional oxygen groups on the surface, thereby improving its efficacy as an oxygen removal agent (Zhao et al., 2017). Furthermore, it aids in the reduction of undesirable reactions such as polymerization, cracking, and coke formation. Although the deoxygenation activity of the Ni-supported AC catalyst is prominent, the catalyst still produces highly undesirable coke formation.

Thus, incorporating metal oxides promoters such as Mn, W, La, Zn, Fe, and Ce to into a binary system could reduce the deactivation reaction rate. It has been proposed that the synergistic interaction of the acidic and basic sites derived from these metals species may allow for improve catalytic stability and deoxygenation activity. Therefore, the current research focuses on developing supported Ni-based heterogenous catalysts on AC for the catalytic deoxygenation of WCO in an H_2-free environment.

1.5 Objectives of the Study

The primary goals of this research are as follows:

1. To synthesise and characterise the physicochemical properties of Ni-based catalysts using the wet impregnated method with other transition metals and various supports.
2. To examine the catalytic performance of the synthesised catalysts and optimise the deoxygenation reaction under various catalytic parameters.
3. To assess the reusability and stability of the catalysts for catalytic deoxygenation of WCO.
4. To determine the fuel properties of green diesel based on the American Society for Testing and Materials (ASTM) method.

1.6 Scope of the Study

The wet-impregnation method was used in this study to synthesise Ni-based heterogenous catalysts. First, the deoxygenation reaction of Ni-based catalysts was investigated using various supports (AC, reduced graphene oxide (rGO), and beta zeolite (Zeo)). The physical properties of the catalysts were determine using XRD, BET, TPD-NH_3, TPD-CO_2, TGA, FESEM-EDX, and XPS. The performance of deoxygenation was evaluated to select the best catalyst with high catalytic activity. The liquid product was tested using GC-FID, GC-MS, GC-TCD, FTIR, and CHNOS. Further research was conducted to investigate the impact of acid-base bimetallic catalysts. Various metals, including Ce, Mn, La, Fe, Zn, and Fe were doped with Ni and screened for the incredible bimetallic catalysts, which produced high diesel-ranged hydrocarbon.

The potent catalysts were used in optimisation studies with a one-variable-at-a-time approach to study the effect of different catalyst loadings, reaction temperatures, and reaction times. The catalysts were then tested for reusability and stability studies. Catalyst reusability studies are critical for estimating the economics of catalysts for large-scale production. Under favourable reaction conditions, the reusability activity was evaluated. Renewable fuel properties are also discussed.

REFERENCES

Abdulkareem-Alsultan, G., Asikin-mijan, N., Lee, H. V., Albazzaz, A. S., & Taufiq-Yap, Y. H. (2017). Deoxygenation of waste cooking to renewable diesel over walnut shell- derived nanorode activated carbon supported CaO-La2O3 catalyst. *Energy Conversion and Management*, *151*, 311–323.

Abdulkareem-Alsultan, G., Asikin-Mijan, N., Lee, H. V., & Taufiq-Yap, Y. H. (2016). A new route for the synthesis of La-Ca oxide supported on nano activated carbon via vacuum impregnation method for one pot esterification-transesterification reaction. *Chemical Engineering Journal*, *304*, 61–71.

Abdulkareem-Alsultan, G., Asikin-Mijan, N., Lee, H. V, Rashid, U., Islam, A., & Taufiq-Yap, Y. H. (2019). A Review on Thermal Conversion of Plant Oil (Edible and Inedible) into Green Fuel Using Carbon - Based Nanocatalyst. *Catalysts*, *9*, 1–25.

Abdulkareem-alsultan, G., Asikin-Mijan, N., Mansir, N., Lee, H. V, Zainal, Z., Islam, A., & Taufiq-Yap, Y. H. (2019). Pyro-lytic de-oxygenation of waste cooking oil for green diesel production over Ag2O3-La2O3/AC nano-catalyst. *Journal of Analytical and Applied Pyrolysis*, *137*, 171–184.

Abdulkareem-Alsultan, G., Asikin-Mijan, N., Mustafa-Alsultan, G., Lee, H. V, Wilson, K., & Taufiq-Yap, Y. H. (2020). Efficient deoxygenation of waste cooking oil over Co3O4–La2O3-doped activated carbon for the production of diesel-like fuel†. *Royal Society of Chemistry*, *10*, 4996–5009.

Abdulkareem-Alsultan, G., Asikin-Mijan, N., Obeas, L. K., Yunus, R., Razali, S. Z., Islam, A., & Taufiq-Yap, Y. H. (2022). In-situ operando and ex-situ study on light hydrocarbon-like-diesel and catalyst deactivation kinetic and mechanism study during deoxygenation of sludge oil. *Chemical Engineering Journal*, *429*, 132206.

Akri, M., Pronier, S., Chafik, T., Achak, O., Granger, P., Simon, P., Trentesaux, M., & Batiot-dupeyrat, C. (2017). Development of nickel supported La and Ce-natural illite clay for autothermal dry reforming of methane : Toward a better resistance to deactivation. *Applied Catalysis B: Environmental*, *205*, 519–531.

Alhikami, A. F., Yao, C., & Wang, W. (2021). A study of the spray ignition characteristics of hydro-processed renewable diesel , petroleum diesel , and biodiesel using a constant volume combustion chamber. *Combustion and Flame*, *223*, 55–64.

Aliana-Nasharuddin, N., Asikin-Mijan, N., Abdulkareem-Alsultan, G., Saiman, M. I., Alharthi, F. A., Alghamdi, A. A., & Taufiq-Yap, Y. H. (2020). Production of green diesel from catalytic deoxygenation of chicken fat oil over a series binary metal oxide-supported MWCNTs †. *Royal Society of Chemistry*, *10*, 626–642.

Alptekin, E., Canakci, M., & Sanli, H. (2014). Biodiesel production from vegetable oil and waste animal fats in a pilot plant. *Waste Management*, *34*(11), 2146–2154.

Amin, A. (2019). Review of diesel production from renewable resources : Catalysis , process kinetics and technologies. *Ain Shams Engineering Journal*, *10*, 821–839.

Ang, B. C., Yaacob, I. I., & Nurdin, I. (2013). Investigation of Fe2O3 / SiO2 Nanocomposite by FESEM and TEM. *Journal of Nanomaterials*, *2013*, 1–6.

Arend, M., Nonnen, T., Hoelderich, W. F., Fischer, J., & Groos, J. (2011). Catalytic deoxygenation of oleic acid in continuous gas flow for the production of diesel-like hydrocarbons. *Applied Catalysis A: General*, *399*(1–2), 198–204.

Arun, N., Sharma, R. V., & Dalai, A. K. (2015). Green diesel synthesis by hydrodeoxygenation of bio-based feedstocks: Strategies for catalyst design and development. *Renewable and Sustainable Energy Reviews*, *48*, 240–255.

Asadieraghi, M., Daud, W. M. A. W., & Abbas, H. F. (2015). Heterogeneous catalysts for advanced bio-fuel production through catalytic biomass pyrolysis vapor upgrading : a review. *RSC Advances*, *5*, 22234–22255.

Asikin-Mijan, N., Lee, H. V., Taufiq-Yap, Y. H., Abdulkrem-Alsultan, G., Mastuli, M. S., & Ong, H. C. (2017). Optimization study of SiO 2 -Al 2 O 3 supported bifunctional acid–base NiO-CaO for renewable fuel production using response surface methodology. *Energy Conversion and Management*, *141*, 325–338.

Asikin-Mijan, N., Lee, H. V., Abdulkareem-Alsultan, G., Afandi, A., & Taufiq-Yap, Y. H. (2017). Production of green diesel via cleaner catalytic deoxygenation of Jatropha curcas oil. *Journal of Cleaner Production*, *167*, 1048–1059.

Asikin-Mijan, N., Lee, H. V., Juan, J. C., Noorsaadah, A. R., Abdulkareem-Alsultan, G., Arumugam, M., & Taufiq-Yap, Y. H. (2016). Waste clamshell-derived CaO supported Co and W catalysts for renewable fuels production via cracking-deoxygenation of triolein. *Journal of Analytical and Applied Pyrolysis*, *120*, 110–120.

Asikin-Mijan, N., Lee, H. V., Juan, J. C., Noorsaadah, A. R., Ong, H. C., Razali, S. M., & Taufiq-Yap, Y. H. (2018). Promoting deoxygenation of triglycerides via Co-Ca loaded SiO2-Al2O3catalyst. *Applied Catalysis A: General*, *552*(August 2017), 38–48.

Asikin-Mijan, N., Lee, H. V., Juan, J. C., Noorsaadah, A. R., & Taufiq-Yap, Y. H. (2017). Catalytic deoxygenation of triglycerides to green diesel over modified CaO-based catalysts. *RSC Advances*, *7*(73), 46445–46460.

Asikin-Mijan, N., Lee, H. V, Marliza, T. S., & Taufiq-Yap, Y. H. (2018). Pyrolytic-deoxygenation of triglycerides model compound and non-edible oil to hydrocarbons over SiO2-Al2O3 supported NiO-CaO catalysts. *Journal of Analytical and Applied Pyrolysis*, *129*, 221–230.

Asikin-mijan, N., Lee, H. V, Taufiq-Yap, Y. H., Juan, J. C., & Rahman, N. A. (2016). Pyrolytic – deoxygenation of triglyceride via natural waste shell derived Ca(OH)2 nanocatalyst. *Journal of Analytical and Applied Pyrolysis*, *117*, 46–55.

Asikin-Mijan, N., Ooi, J. M., AbdulKareem-Alsultan, G., Lee, H. V, Mastuli, M. S.,

Mansir, N., Alharthi, F. A., Alghamdi, A. A., & Taufiq-Yap, Y. H. (2020). Free-H2 deoxygenation of Jatropha curcas oil into cleaner diesel-grade biofuel over coconut residue-derived activated carbon catalyst. *Journal of Cleaner Production*, *249*, 119381.

Asikin-Mijan, N., Rosman, N. A., Abdulkareem-alsultan, G., Mastuli, M. S., Lee, H. V, Nabihah-Fauzi, N., Lokman, I. M., Alharthi, F. A., … Taufiq-yap, Y. H. (2020). Production of renewable diesel from Jatropha curcas oil via pyrolytic-deoxygenation over various multi-wall carbon nanotube-based catalysts. *Process Safety and Environmental Protection*, *142*, 336–349.

Aslam, M., Konwar, L. J., Sarma, A. K., & Kothiyal, N. C. (2015). An investigation of catalytic hydrocracking of high FFA vegetable oils to liquid hydrocarbons using biomass derived heterogeneous catalysts. *Journal of Analytical and Applied Pyrolysis*, *115*, 401–409.

Asplund, S. (1996). Coke Formation and Its Effect on Internal Mass Transfer and Selectivity in Pd-Catalysed Acetylene Hydrogenation. *Journal of Catalysis*, *158*, 267–278.

Avhad, M. R., & Marchetti, J. M. (2015). A review on recent advancement in catalytic materials for biodiesel production. *Renewable and Sustainable Energy Reviews*, *50*, 696–718.

Aysu, T., Rahman, N. A. A., & Sanna, A. (2016). Catalytic pyrolysis of Tetraselmis and Isochrysis microalgae by nickel ceria based catalysts for hydrocarbon production. *Energy*, *103*, 205–214.

Azreena, I. N., Lau, H. L. N., Asikin-Mijan, N., Hassan, M. A., Izham, S. M., Kennedy, E., Stockenhuber, M., Mastuli, M. S., … Taufiq-Yap, Y. H. (2021). A promoter effect on hydrodeoxygenation reactions of oleic acid by zeolite beta catalysts. *Journal of Analytical and Applied Pyrolysis*, *155*, 105044.

Azri, N., Ramli, I., Nda-Umar, U. I., Shamsuddin, M. R., Saiman, M. I., & Taufiq-Yap, Y. H. (2020). Copper-dolomite as effective catalyst for glycerol hydrogenolysis to 1,2-propanediol. *Journal of the Taiwan Institute of Chemical Engineers*, *112*, 34–51.

Baharudin, K. B., Abdullah, N., Taufiq-Yap, Y. H., & Derawi, D. (2020). Renewable diesel via solventless and hydrogen-free catalytic deoxygenation of palm fatty acid distillate. *Journal of Cleaner Production*, *274*, 122850.

Balasundram, V., Ibrahim, N., Kasmani, R. M., Isha, R., Hamid, M. K. A., Ali, R. R., & Hasbullah, H. (2018). Catalytic upgrading of sugarcane bagasse pyrolysis vapours over rare earth metal (Ce) loaded HZSM-5 : Effect of catalyst to biomass ratio on the organic compounds in pyrolysis oil ☆. *Applied Energy*, *220*, 787–799.

Balasundram, V., Zaman, K. K., Ibrahim, N., Kasmani, R. M., Isha, R., Hamid, M. K. A., & Hasbullah, H. (2018). Catalytic upgrading of pyrolysis vapours over metal modified HZSM-5 via in-situ pyrolysis of sugarcane bagasse : Effect of nickel to cerium ratio on HZSM-5. *Journal of Analytical and Applied Pyrolysis*, *134*, 309–325.

Baleţentis, T., Streimikiene, D., Zhang, T., & Liobikiene, G. (2019). The role of bioenergy in greenhouse gas emission reduction in EU countries: An Environmental Kuznets Curve modelling. *Resources, Conservation and Recycling*, *142*, 225–231.

Bankovic-Ilic, I. B., Stojkovic, I. J., Stamenkovic, O. S., Veljkovic, V. B., & Hung, Y.-T. (2014). Waste animal fats as feedstocks for biodiesel production. *Renewable and Sustainable Energy Reviews*, *32*, 238–254.

Ben, H., & Ragauskas, A. J. (2012). One step thermal conversion of lignin to the gasoline range liquid products by using zeolites as additives. *RSC Advances*, *2*, 12892–12898.

Bernas, H., Eränen, K., Simakova, I., Leino, A., Kordás, K., Myllyoja, J., Mäki-arvela, P., Salmi, T., & Murzin, D. Y. (2010). Deoxygenation of dodecanoic acid under inert atmosphere. *Fuel*, *89*, 2033–2039.

Bezergianni, S., & Dimitriadis, A. (2013). Comparison between different types of renewable diesel. *Renewable and Sustainable Energy Reviews*, *21*, 110–116.

Bezergianni, S., Dimitriadis, A., Kikhtyanin, O., & Kubicka, D. (2018). Refinery co-processing of renewable feeds. *Progress in Energy and Combustion Science*, *68*, 29–64.

Biswas, S., Katiyar, R., Gurjar, B. R., & Pruthi, V. (2017). Biofuels and Their Production Through Different Catalytic Routes. *Chemical and Biochemical Engineering Quarterly*, *31*(1), 47–62.

Bohre, A., Alam, M. I., Avasthi, K., Ruiz-Zepeda, F., & Likozar, B. (2020). Low temperature transformation of lignocellulose derived bioinspired molecules to aviation fuel precursor over magnesium–lanthanum mixed oxide catalyst. *Applied Catalysis B: Environmental*, *276*(May), 119069.

Botas, J. A., Serrano, D. P., García, A., & Ramos, R. (2014). Catalytic conversion of rapeseed oil for the production of raw chemicals , fuels and carbon nanotubes over Ni-modified nanocrystalline and hierarchical ZSM-5. *Applied Catalysis B: Environmental*, *145*, 205–215.

Cao, X., Li, L., Yu, S., Liu, S., Yu, H., Wu, Q., & Ragauskas, A. J. (2019). Catalytic conversion of waste cooking oils for the production of liquid hydrocarbon biofuels using in-situ coating metal oxide on SBA-15 as heterogeneous catalyst. *Journal of Analytical and Applied Pyrolysis*, *138*(May 2018), 137–144.

Cao, X., Long, F., Zhai, Q., Liu, P., Xu, J., & Jiang, J. (2020). Enhancement of fatty acids hydrodeoxygenation selectivity to diesel-range alkanes over the supported Ni-MoOx catalyst and elucidation of the active phase. *Renewable Energy*, *162*, 2113–2125.

Cheah, K. W., Taylor, M. J., Osatiashtiani, A., Beaumont, S. K., Nowakowski, D. J., Yusup, S., Bridgwater, A. V., & Kyriakou, G. (2020). Monometallic and bimetallic catalysts based on Pd, Cu and Ni for hydrogen transfer deoxygenation of a prototypical fatty acid to diesel range hydrocarbons. *Catalysis Today*, *355*(January

2019), 882–892.

Cheah, K. W., Yusup, S., Kyriakou, G., Ameen, M., Taylor, M. J., Nowakowski, D. J., Bridgwater, A. V, & Uemura, Y. (2019). In-situ hydrogen generation from 1,2,3,4-tetrahydronaphthalene for catalytic conversion of oleic acid to diesel fuel hydrocarbons : Parametric studies using Response Surface Methodology approach. *International Journal of Hydrogen Energy*, *44*(37), 20678–20689.

Chen, G., Liu, J., Li, X., Zhang, J., Yin, H., & Su, Z. (2020). Investigation on catalytic hydrodeoxygenation of eugenol blend with light fraction in bio-oil over Ni-based catalysts. *Renewable Energy*, *157*, 456–465.

Chen, J., Zou, H., Yao, Q., Luo, M., Li, X., & Lu, Z.-H. (2020). Cr2O3-modified NiFe nanoparticles as a noble-metal-free catalyst for complete dehydrogenation of hydrazine in aqueous solution. *Applied Surface Science*, *501*(August 2019), 144247.

Chen, L., Zhang, F., Li, G., & Li, X. (2017). Effect of Zn/Al ratio of Ni/ZnO-Al2O3 catalysts on the catalytic deoxygenation of oleic acid into alkane. *Applied Catalysis A: General*, *529*, 175–184.

Cheng, S., Wei, L., Julson, J., & Rabnawaz, M. (2017). Upgrading pyrolysis bio-oil through hydrodeoxygenation (HDO) using non-sulfided Fe-Co/SiO2 catalyst. *Energy Conversion and Management*, *150*(August), 331–342.

Cho, S., Jang, J., Lee, J. S., & Lee, K.-H. (2010). Carbon-doped ZnO nanostructures synthesized using vitamin C for visible light photocatalysis †. *CrystEngComm*, *12*, 3929–3935.

Choo, M., Oi, L. E., Ling, T. C., Ng, E., Lin, Y., Centi, G., & Juan, J. C. (2020). Deoxygenation of triolein to green diesel in the H2-free condition : Effect of transition metal oxide supported on zeolite Y. *Journal of Analytical and Applied Pyrolysis*, *147*(February), 104797.

Crawford, J. M., Jasinski, J. B., & Carreon, M. A. (2021). Towards continuous deoxygenation of acetic acid catalyzed by recyclable mono/bi/trimetallic zeolite catalysts. *Journal of Catalysis*, *401*, 137–148.

Cruz-Flores, V. G. D. la, Martinez-Hernandez, A., & Gracia-Pinilla, M. A. (2020). Deactivation of Ni-SiO2 catalysts that are synthetized via a modified direct synthesis method during the dry reforming of methane. *Applied Catalysis A, General*, *594*(August 2019), 117455.

Dawes, G. J. S., Scott, E. L., Nôtre, J. Le, Sanders, J. P. M., & Bitter, J. H. (2015). Deoxygenation of biobased molecules by decarboxylation and decarbonylation – a review on the role of heterogeneous, homogeneous and bio-catalysis. *Green Chemistry*, *17*, 3231–3250.

Demirbas, A. (2002). Biodiesel from vegetable oils via transesterification in supercritical methanol. *Energy Conversion and Management*, *43*, 2349–2356.

Demirbas, A. (2009). Biofuels securing the planet ' s future energy needs. *Energy*

Conversion and Management, *50*(9), 2239–2249.

Deng, J., Li, M., & Wang, Y. (2016). Biomass-derived carbon: synthesis and applications in energy storage and conversion. *Green Chemistry*, *18*, 4824–4854.

Dhawane, S. H., Kumar, T., & Halder, G. (2019). Insight into biodiesel synthesis using biocatalyst designed through lipase immobilization onto waste derived microporous carbonaceous support. *Process Safety and Environmental Protection*, *124*, 231–239.

Dickinson, J. G., & Savage, P. E. (2014). Stability and activity of Pt and Ni catalysts for hydrodeoxygenation in supercritical water. *Journal of Molecular Catalysis A: Chemical*, *388–389*, 56–65.

Ding, R., Wu, Y., Chen, Y., Liang, J., Liu, J., & Yang, M. (2015). Effective hydrodeoxygenation of palmitic acid to diesel-like hydrocarbons over MoO2/CNTs catalyst. *Chemical Engineering Science*, *135*, 517–525.

Diya'uddeen, B. H., Aziz, A. R. A., Daud, W. M. A. W., & Chakrabarti, M. H. (2012). Performance evaluation of biodiesel from used domestic waste oils : A review. *Process Safety and Environmental Protection*, *90*, 164–179.

Dominguez-Barroso, M. V, Herrera, C., Larrubia, M. A., & Alemany, L. J. (2016). Diesel oil-like hydrocarbon production from vegetable oil in a single process over Pt – Ni / Al2O3 and Pd / C combined catalysts. *Fuel Processing Technology*, *148*, 110–116.

Douvartzides, S. L., Charisiou, N. D., Papageridis, K. N., & Goula, M. A. (2019). Green diesel: Biomass feedstocks, production technologies, catalytic research, fuel properties and performance in compression ignition internal combustion engines. *Energies*, *12*(5), 1–41.

Dragu, A., Kinayyigit, S., García-suárez, E. J., Florea, M., Stepan, E., Velea, S., Tanase, L., Colliere, V., … Parvulescu, V. I. (2015). Deoxygenation of oleic acid : Influence of the synthesis route of Pd/mesoporous carbon nanocatalysts onto their activity and selectivity. *Applied Catalysis A: General*, *504*, 81–91.

Du, X., Liang, W., Hao, X., Zhou, K., Yang, H., Lei, X., Li, D., & Hu, C. (2021). The effect of support on nickel phosphide catalysts for one-pot conversion of jatropha oil into high grade hydrocarbons. *Catalysis Today*, *367*(August 2020), 83–94.

Duan, P., Zhang, C., Wang, F., Fu, J., Lü, X., Xu, Y., & Shi, X. (2016). Activated carbons for the hydrothermal upgrading of crude duckweed bio-oil. *Catalysis Today*, *274*, 73–81.

Echeandia, S., Pawelec, B., Barrio, V. L., Arias, P. L., Cambra, J. F., Loricera, C. V, & Fierro, J. L. G. (2014). Enhancement of phenol hydrodeoxygenation over Pd catalysts supported on mixed HY zeolite and Al2O3. An approach to O-removal from bio-oils. *Fuel*, *117*, 1061–1073.

Fan, X., Wu, Y., Tu, R., Sun, Y., Jiang, E., & Xu, X. (2020). Hydrodeoxygenation of guaiacol via rice husk char supported Ni based catalysts: The influence of char

supports. *Renewable Energy*, *157*, 1035–1045.

Fang, H., Zheng, J., Luo, X., Du, J., Roldan, A., Leoni, S., & Yuan, Y. (2017). Product tunable behavior of carbon nanotubes-supported Ni–Fe catalysts for guaiacol hydrodeoxygenation. *Applied Catalysis A: General*, *529*, 20–31.

Farabi, M. S. A., Ibrahim, M. L., Rashid, U., & Taufiq-Yap, Y. H. (2019). Esterification of palm fatty acid distillate using sulfonated carbon-based catalyst derived from palm kernel shell and bamboo. *Energy Conversion and Management*, *181*, 562–570.

Fu, J., Lu, X., & Savage, P. E. (2010). Catalytic hydrothermal deoxygenation of palmitic acid. *Energy and Environmetal Science*, *3*, 311–317.

Fu, L., Li, Y., Cui, H., Ba, W., & Liu, Y. (2021). Highly stable and selective catalytic deoxygenation of renewable bio-lipids over Ni/CeO2-Al2O3 for N-alkanes. *Applied Catalysis A: General*, *623*, 118258.

Fukuyama, H., & Terai, S. (2007). An active carbon catalyst prevents coke formation from asphaltenes during the hydrocracking of vacuum residue. *Petroleum Science and Technology*, *25*(1–2), 231–240.

Galadima, A., & Muraza, O. (2015). Catalytic upgrading of vegetable oils into jet fuels range hydrocarbons using heterogeneous catalysts: A review. *Journal of Industrial and Engineering Chemistry*, *29*, 12–23.

Gamal, M. S., Asikin-Mijan, N., Arumugam, M., Rashid, U., & Taufiq-Yap, Y. H. (2019). Solvent-free catalytic deoxygenation of palm fatty acid distillate over cobalt and manganese supported on activated carbon originating from waste coconut shell. *Journal of Analytical and Applied Pyrolysis*, *144*, 104690.

Gamal, M. S., Asikin-Mijan, N., Khalit, W. N. A. W., Arumugam, M., Izham, S. M., & Taufiq-Yap, Y. H. (2020). Effective catalytic deoxygenation of palm fatty acid distillate for green diesel production under hydrogen-free atmosphere over bimetallic catalyst CoMo supported on activated carbon. *Fuel Processing Technology*, *208*, 106519.

Gao, F., Zang, Y. H., Wang, Y., Guan, C.-Q., Qu, J.-Y., & Wu, M.-B. (2021). A review of the synthesis of carbon materials for energy storage from biomass and coal/heavy oil waste. *New Carbon Materials*, *36*(1), 34–48.

Gao, X., Wang, Z., Ashok, J., & Kawi, S. (2020). A comprehensive review of anti-coking, anti-poisoning and anti-sintering catalysts for biomass tar reforming reaction. *Chemical Engineering Science: X*, *7*, 100065.

Garcia, R., Peralta, L., Segura, C., Sepulveda, C., Ghampson, I. T., & Escalona, N. (2016). Study of the Catalytic Conversion and Adsorption of Abietic Acid on Activated Carbon: Effect of Surface Acidity. *J. Chil. Chem. Soc.*, *4*, 3239–3245.

Ghogia, A. C., Nzihou, A., Serp, P., Soulantica, K., & Minh, D. P. (2021). Cobalt catalysts on carbon-based materials for Fischer-Tropsch synthesis: a review. *Applied Catalysis A, General*, *609*, 117906.

Giakoumis, E. G., & Sarakatsanis, C. K. (2018). Estimation of biodiesel cetane number, density, kinematic viscosity and heating values from its fatty acid weight composition. *Fuel*, *222*, 574–585.

Gómez, J. M., Romero, M. D., & Callejo, V. (2013). Heterogeneous basic catalysis for upgrading of biofuels. *Catalysis Today*, *218–219*, 143–147.

Gosselink, R. W., Hollak, S. A. W., Chang, S. W., Van Haveren, J., De Jong, K. P., Bitter, J. H., & Van Es, D. S. (2013). Reaction pathways for the deoxygenation of vegetable oils and related model compounds. *ChemSusChem*, *6*(9), 1576–1594.

Gousi, M., Andriopoulou, C., Bourikas, K., Ladas, S., Sotiriou, M., Kordulis, C., & Lycourghiotis, A. (2017). Green diesel production over nickel-alumina co-precipitated catalysts. *Applied Catalysis A: General*, *536*, 45–56.

Gousi, M., Kordouli, E., Bourikas, K., Simianakis, E., Ladas, S., Panagiotou, G. D., Kordulis, C., & Lycourghiotis, A. (2020). Green diesel production over nickel-alumina nanostructured catalysts promoted by zinc. *Catalysis Today*, *355*(February 2019), 903–909.

Greluk, M., Rotko, M., & Turczyniak-surdacka, S. (2020). Comparison of catalytic performance and coking resistant behaviors of cobalt- and nickel based catalyst with different Co / Ce and Ni / Ce molar ratio under SRE conditions. *Applied Catalysis A, General*, *590*(July 2019), 117334.

Gross, S. (2020). *Why are fossil fuels so hard to quit?* Brookings. https://www.brookings.edu/essay/why-are-fossil-fuels-so-hard-to-quit/

Guclu, C., Alper, K., Erdem, M., Tekin, K., & Karagoz, S. (2021). Activated carbons from co-carbonization of waste truck tires and spent tea leaves. *Sustainable Chemistry and Pharmacy*, *21*(December 2020), 100410.

Gui, M. M., Lee, K. T., & Bhatia, S. (2008). Feasibility of edible oil vs . non-edible oil vs . waste edible oil as biodiesel feedstock. *Energy*, *33*(October 2007), 1646–1653.

Guisnet, M., & Magnoux, P. (2001). Organic chemistry of coke formation. *Applied Catalysis A : General*, *212*, 83–96.

Guo, X., Zheng, Y., Zhang, B., & Chen, J. (2009). Analysis of coke precursor on catalyst and study on regeneration of catalyst in upgrading of bio-oil. *Biomass and Bioenergy*, *33*, 1469–1473.

Guo, Y., Tan, C., Sun, J., Li, W., Zhang, J., & Zhao, C. (2020). Porous activated carbons derived from waste sugarcane bagasse for CO2 adsorption. *Chemical Engineering Journal*, *381*(July 2019), 122736.

Hackbarth, F. V., Vilar, V. J. P., De Souza, G. B., De Souza, S. M. A. G. U., & De Souza, A. A. U. (2014). Benzene, toluene and o-xylene (BTX) removal from aqueous solutions through adsorptive processes. *Adsorption*, *20*(4), 577–590.

Hafeez, S., Al-salem, S. M., Papageridis, K. N., Charisiou, N. D., Goula, M. A., Manos, G., & Constantinou, A. (2021). Theoretical Investigation of the Deactivation of Ni

Supported Catalysts for the Catalytic Deoxygenation of Palm Oil for Green Diesel Production. *Catalysts*, *11*, 747.

Hafriz, R. S. R. M., Arifin, N. A., Salmiaton, A., Yunus, R., Taufiq-Yap, Y. H., Saifuddin, N. M., & Shamsuddin, A. H. (2022). Multiple-objective optimization in green fuel production via catalytic deoxygenation reaction with NiO-dolomite catalyst. *Fuel*, *308*, 122041.

Hafriz, R. S. R. M., Salmiaton, A., Yunus, R., & Taufiq-Yap, Y. H. (2018). Green Biofuel Production via Catalytic Pyrolysis of Waste Cooking Oil using Malaysian Dolomite Catalyst. *Bulletin of Chemical Reaction Engineering & Catalysis*, *13*(3), 489–501.

Hafriz, R. S. R. M., Shafizah, I. N., Arifin, N. A., Salmiaton, A., Yunus, R., Taufiq-Yap, Y. H., & Shamsuddin, A. H. (2021). Effect of Ni/Malaysian dolomite catalyst synthesis technique on deoxygenation reaction activity of waste cooking oil. *Renewable Energy*, *178*, 128–143.

Hafriz, R. S. R. M., Shafizah, I. N., Salmiaton, A., Arifin, N. A., Yunus, R., Taufiq-Yap, Y. H., & Halim, S. A. (2020). Comparative study of transition metal-doped calcined Malaysian dolomite catalyst for WCO deoxygenation reaction. *Arabian Journal of Chemistry*, *13*(11), 8146–8159.

Haiyan, G. U. O., Lunjie, M. A., Fei, S., Gang, Y., Yanzong, Z., Shihuai, D., Jing, Z., Chun, S., & Yongmei, Z. (2017). Effects of La-involvement on biomass pyrolysis behaviors and properties of produced biochar. *Journal of Rare Earths*, *35*(6), 593–601.

Hamid, S. A., Azha, S. F., Sellaoui, L., Bonilla-petriciolet, A., & Ismail, S. (2020). Adsorption of copper (II) cation on polysulfone / zeolite blend sheet membrane: Synthesis , characterization , experiments and adsorption modelling. *Colloids and Surfaces A*, *601*(March), 124980.

Hamza, M., Ayoub, M., Shamsuddin, R. Bin, Mukhtar, A., Saqib, S., Zahid, I., Ameen, M., Ullah, S., … Ibrahim, M. (2021). A review on the waste biomass derived catalysts for biodiesel production. *Environmental Technology & Innovation*, *21*, 101200.

Han, J., Duan, J., Chen, P., Lou, H., Zheng, X., & Hong, H. (2011). Nanostructured molybdenum carbides supported on carbon nanotubes as efficient catalysts for one-step hydrodeoxygenation and isomerization of vegetable oils. *Green Chemistry*, *13*, 2561–2568.

Han, J., Duan, J., Chen, P., Lou, H., Zheng, X., & Hong, H. (2012). Carbon-Supported Molybdenum Carbide Catalysts for the Conversion of Vegetable Oils. *ChemSusChem*, *5*, 727–733.

Han, J., Sun, H., Ding, Y., Lou, H., & Zheng, X. (2010). Palladium-catalyzed decarboxylation of higher aliphatic esters : Towards a new protocol to the second generation biodiesel production †. *Green Chemistry*, *12*, 463–467.

Han, Q., Rehman, M. U., Wang, J., Rykov, A., Gutiérrez, O. Y., Zhao, Y., Wang, S., Ma,

X., & Lercher, J. A. (2019). The synergistic effect between Ni sites and Ni-Fe alloy sites on hydrodeoxygenation of lignin-derived phenols. *Applied Catalysis B: Environmental*, *253*, 348–358.

Harikrishna, S., Robert, A. R., Ganja, H., Maddila, S., & Jonnalagadda, S. B. (2020). A green, efficient and recoverable CeO2/MWCNT nanocomposite catalyzed click synthesis of pyridine-3-carboxamides. *Applied Organometallic Chemistry*, *April*, 1–8.

Harris, P. J. F., Liu, Z., & Suenaga, K. (2008). Imaging the atomic structure of activatedcarbon. *Journal of Physics: Condensed Matter*, *20*(36), 362201.

He, T., Liu, X., Ge, Y., Han, D., Li, J., Wang, Z., & Wu, J. (2017). Gas phase hydrodeoxygenation of anisole and guaiacol to aromatics with a high selectivity over Ni-Mo/SiO2. *Catalysis Communications*, *102*, 127–130.

He, Z., & Wang, X. (2013). Hydrodeoxygenation of model compounds and catalytic systems for pyrolysis bio-oils upgrading. *Catalysis for Sustainable Energy*, *1*, 28–52.

Hermida, L., Abdullah, A. Z., & Mohamed, A. R. (2015). Deoxygenation of fatty acid to produce diesel-like hydrocarbons: A review of process conditions, reaction kinetics and mechanism. *Renewable and Sustainable Energy Reviews*, *42*, 1223–1233.

Hermida, L., Amani, H., Abdullah, A. Z., & Mohamed, A. R. (2016). Deoxygenation of Palmitic Acid to Produce Diesel-like Hydrocarbons over Nickel Incorporated Cellular Foam Catalyst: A Kinetic Study. *Journal of Advanced Chemical Engineering*, *6*(1), 1–8.

Hollak, S. A. W., Ariens, M. A., Jong, K. P. De, & Es, D. S. Van. (2014). Hydrothermal Deoxygenation of Triglycerides over Pd/C aided by In Situ Hydrogen Production from Glycerol Reforming. *ChemSusChem*, *7*, 1057–1062.

Hongloi, N., Prapainainar, P., & Prapainainar, C. (2021). Review of green diesel production from fatty acid deoxygenation over Ni-based catalysts. *Molecular Catalysis*, 111696.

Hongloi, N., Prapainainar, P., Seubsai, A., Sudsakorn, K., & Prapainainar, C. (2019). Nickel catalyst with different supports for green diesel production. *Energy*, *182*, 306–320.

Hossain, R., Nekouei, R. K., Mansuri, I., & Sahajwalla, V. (2021). In-situ O/N-heteroatom enriched activated carbon by sustainable thermal transformation of waste coffee grounds for supercapacitor material. *Journal of Energy Storage*, *33*(September 2020), 102113.

Huber, G. W., & Corma, A. (2007). Synergies between Bio- and Oil Refineries for the Production of Fuels from Biomass Angewandte. *Angew. Chem. Int. Ed*, *46*, 7184–7201.

Hui-Min, W., Yan-Ping, M., Xi-Ying, C., Si-Yuan, X., Jin-Ding, C., Qiu-Lin, Z., Bin,

Z., & Ping, N. (2020). Promoting effect of SO42- functionalization on the performance of Fe2O3 catalyst in the selective catalytic reduction of NOx with NH3. *Journal of Fuel Chemistry and Technology*, *48*(5), 584–593.

Ibrahim, S. F., Asikin-mijan, N., Ibrahim, M. L., Abdulkareem-alsultan, G., Izham, S. M., & Taufiq-Yap, Y. H. (2020). Sulfonated functionalization of carbon derived corncob residue via hydrothermal synthesis route for esterification of palm fatty acid distillate. *Energy Conversion and Management*, *210*, 112698.

Inventory of U.S. Greenhouse Gas Emissions and Sinks. (2021). United States Environmental Protection Agency. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks

Isha, R., & Williams, P. T. (2012). Experimental design methodology for optimising catalytic performance of Ni/Ce/α-Al2O3 catalyst for methane steam reforming. *Journal of the Energy Institute*, *September*, 22–28.

Ishihara, A., Kawaraya, D., Sonthisawate, T., Kimura, K., Hashimoto, T., & Nasu, H. (2015). Catalytic cracking of soybean oil by hierarchical zeolite containing mesoporous silica-aluminas using a Curie point pyrolyzer. *Journal of Molecular Catalysis A: Chemical*, *396*, 310–318.

ITF Transport Outlook. (2019). *Transport demand set to triple, but sector faces potential distruption*. https://www.itf-oecd.org/transport-demand-set-triple-sector-faces-potential-disruptions#:~:text=Passenger transport will increase nearly,Forum%2C an intergovernmental think tank.

Janampelli, S., & Darbha, S. (2018). Effect of support on the catalytic activity of WOx promoted Pt in green diesel production. *Molecular Catalysis*, *451*, 125–134.

Jeon, K., Na, H., Lee, Y., Ahn, S., Kim, K., Shim, J.-O., Jang, W.-J., Jeong, D.-W., … Roh, H.-S. (2019). Catalytic deoxygenation of oleic acid over a Ni-CeZrO2 catalyst. *Fuel*, *258*(May), 116179.

Jeong, J., Lee, H. W., Jang, S. H., Ryu, S., Kim, Y., Park, R., Jung, S.-C., Jeon, J.-K., & Park, Y.-K. (2019). In-Situ Catalytic Fast Pyrolysis of Pinecone over HY Catalysts. *Catalysts*, *9*(1034), 1–11.

Jin, M., & Choi, M. (2019). Hydrothermal deoxygenation of triglycerides over carbon-supported bimetallic PtRe catalysts without an external hydrogen source. *Molecular Catalysis*, *474*, 110419.

Kaewmeesri, R., Nonkumwong, J., Kiatkittipong, W., Laosiripojana, N., & Faungnawakij, K. (2021). Deoxygenations of palm oil-derived methyl esters over mono- and bimetallic NiCo catalysts. *Journal of Environmental Chemical Engineering*, *9*(2), 105128.

Kaewmeesri, R., Srifa, A., Itthibenchapong, V., & Faungnawakij, K. (2015). Deoxygenation of Waste Chicken Fats to Green Diesel over Ni/Al2O3 : Effect of Water and Free Fatty Acid Content. *Energy and Fuels*, *29*, 833–840.

Kalghatgi, G. (2018). Is it really the end of internal combustion engines and petroleum

in transport? *Applied Energy*, *225*, 965–974.

Kalghatgi, G. (2019). Development of Fuel/Engine Systems—The Way Forward to Sustainable Transport. *Engineering*, *5*(3), 510–518.

Kalnes, T. N., Koers, K. P., Marker, T., & Shonnard, D. R. (2009). A Technoeconomic and Environmental Life Cycle Comparison of Green Diesel to Biodiesel and Syndiesel. *Environmental Progress & Sustainable Energy*, *28*(1), 111–120.

Kamaruzaman, M. F., Taufiq-Yap, Y. H., & Derawi, D. (2020). Green diesel production from palm fatty acid distillate over SBA-15-supported nickel, cobalt, and nickel/cobalt catalysts. *Biomass and Bioenergy*, *134*(January), 105476.

Karkal, S. S., & Kudre, T. G. (2020). Valorization of fish discards for the sustainable production of renewable fuels. *Journal of Cleaner Production*, *275*, 122985.

Karmakar, R., Kundu, K., & Rajor, A. (2018). Fuel properties and emission characteristics of biodiesel produced from unused algae grown in India. *Petroleum Science*, *15*(2), 385–395.

Keskin, A., Şen, M., & Emiroğlu, A. O. (2020). Experimental studies on biodiesel production from leather industry waste fat and its effect on diesel engine characteristics. *Fuel*, *276*(February), 118000.

Khalit, W. N. A. W., Asikin-Mijan, N., Marliza, T. S., Gamal, M. S., Shamsuddin, M. R., Saiman, M. I., & Taufiq-Yap, Y. H. (2021). Catalytic deoxygenation of waste cooking oil utilizing nickel oxide catalysts over various supports to produce renewable diesel fuel. *Biomass and Bioenergy*, *154*, 106248.

Khalit, W. N. A. W., Marliza, T. S., Asikin-Mijan, N., Gamal, M. S., Saiman, M. I., Ibrahim, M. L., & Taufiq-Yap, Y. H. (2020). Development of bimetallic nickel-based catalysts supported on activated carbon for green fuel production. *RSC Advances*, *10*, 37218–37232.

Khan, S., Kay Lup, A. N., Qureshi, K. M., Abnisa, F., Wan Daud, W. M. A., & Patah, M. F. A. (2019). A review on deoxygenation of triglycerides for jet fuel range hydrocarbons. *Journal of Analytical and Applied Pyrolysis*, *140*, 1–24.

Khodadadi, M. R., Malpartida, I., Tsang, C. W., Lin, C. S. K., & Len, C. (2020). Recent advances on the catalytic conversion of waste cooking oil. *Molecular Catalysis*, *494*(July), 111128.

Kim, I., Dwiatmoko, A. A., Choi, J., Suh, D. J., Jae, J., Ha, J., & Kim, J. (2017). Upgrading of sawdust pyrolysis oil to hydrocarbon fuels using tungstate-zirconia-supported Ru catalysts with less formation of cokes. *Journal of Industrial and Engineering Chemistry*, *56*, 74–81.

Kim, S., Kwon, E. E., Kim, Y. T., Jung, S., Kim, H. J., Huber, G. W., & Lee, J. (2019). Recent advances in hydrodeoxygenation of biomass-derived oxygenates over heterogeneous catalysts. *Green Chemistry*, *21*, 3715–3743.

Kim, S. M., Lee, M. E., Choi, J., Suh, D. J., & Suh, Y. (2011). Conversion of biomass-

derived butanal into gasoline-range branched hydrocarbon over Pd-supported catalysts. *Catalysis Communications*, *16*(1), 108–113.

Kiméné, A., Wojcieszak, R., Paul, S., & Dumeignil, F. (2019). Catalytic decarboxylation of fatty acids to hydrocarbons over non-noble metal catalysts: the state of the art. *Journal of Chemical Technology and Biotechnology*, *94*(3), 658–669.

Knothe, G. (2010). Biodiesel and renewable diesel: A comparison. *Progress in Energy and Combustion Science*, *36*(3), 364–373.

Konwar, L. J., Boro, J., & Deka, D. (2014). Review on latest developments in biodiesel production using carbon-based catalysts. *Renewable and Sustainable Energy Reviews*, *29*, 546–564.

Konwar, L. J., Mäki-Arvela, P., & Mikkola, J. P. (2019). SO3H-Containing Functional Carbon Materials: Synthesis, Structure, and Acid Catalysis. *Chemical Reviews*, *119*(22), 11576–11630.

Kordulis, C., Bourikas, K., Gousi, M., Kordouli, E., & Lycourghiotis, A. (2016). Development of nickel based catalysts for the transformation of natural triglycerides and related compounds into green diesel: A critical review. *Applied Catalysis B: Environmental*, *181*, 156–196.

Kotwal, M. S., Niphadkar, P. S., Deshpande, S. S., Bokade, V. V., & Joshi, P. N. (2009). Transesterification of sunflower oil catalyzed by flyash-based solid catalysts. *Fuel*, *88*(9), 1773–1778.

Krobkrong, N., Itthibenchapong, V., Khongpracha, P., & Faungnawakij, K. (2018). Deoxygenation of oleic acid under an inert atmosphere using molybdenum oxide-based catalysts. *Energy Conversion and Management*, *167*, 1–8.

Kubička, D., Bejblová, M., & Vlk, J. (2010). Conversion of vegetable oils into hydrocarbons over CoMo/MCM-41 catalysts. *Topics in Catalysis*, *53*(3–4), 168–178.

Kubička, D., Horáček, J., Setnička, M., Bulánek, R., Zukal, A., & Kubičková, I. (2014). Effect of support-active phase interactions on the catalyst activity and selectivity in deoxygenation of triglycerides. *Applied Catalysis B: Environmental*, *145*, 101–107.

Kubicka, D., & Kaluza, L. (2010). Deoxygenation of vegetable oils over sulfided Ni , Mo and NiMo catalysts. *Applied Catalysis A: General*, *372*, 199–208.

Kubickova, I., & Kubicka, D. (2010). Utilization of Triglycerides and Related Feedstocks for Production of Clean Hydrocarbon Fuels and Petrochemicals : A Review. *Waste Biomass Valor*, *1*, 293–308.

Kukushkin, R. G., Yeletsky, P. M., Grassin, C. T., Chen, B. H., Bulavchenko, O. A., Saraev, A. A., & Yakovlev, V. A. (2020). Deoxygenation of esters over sulfur-free Ni–W/Al2O3 catalysts for production of biofuel components. *Chemical Engineering Journal*, *396*(January), 125202.

Kulkarni, M. G., & Dalai, A. K. (2006). Waste Cooking Oil- An Economical Source for Biodiesel : A Review. *Ind. Eng. Chem. Res.*, *45*, 2901–2913.

Kumar, P., Yenumala, S. R., Maity, S. K., & Shee, D. (2014). Kinetics of hydrodeoxygenation of stearic acid using supported nickel catalysts : Effects of supports. *Applied Catalysis A : General*, *471*, 28–38.

Kumar, S., Shamsuddin, M. R., Farabi, M. S. A., Saiman, M. I., Zainal, Z., & Taufiq-yap, Y. H. (2020). Production of methyl esters from waste cooking oil and chicken fat oil via simultaneous esterification and transesterification using acid catalyst. *Energy Conversion and Management*, *226*, 113366.

Kuo, G. (2019). *When fossil fuels run out, what then?* https://mahb.stanford.edu/library-item/fossil-fuels-run/

Lam, S. S., Russell, A. D., & Chase, H. A. (2010). Microwave pyrolysis, a novel process for recycling waste automotive engine oil. *Energy*, *35*(7), 2985–2991.

Lapuerta, M., Armas, O., Hernández, J. J., & Tsolakis, A. (2010). Potential for reducing emissions in a diesel engine by fuelling with conventional biodiesel and Fischer-Tropsch diesel. *Fuel*, *89*(10), 3106–3113.

Lee, D. W., & Yoo, B. R. (2014). Advanced metal oxide (supported) catalysts: Synthesis and applications. *Journal of Industrial and Engineering Chemistry*, *20*(6), 3947–3959.

Leistner, K., Xie, K., Kumar, A., Kamasamudram, K., & Olsson, L. (2017). Ammonia Desorption Peaks Can Be Assigned to Different Copper Sites in Cu/SSZ-13. *Catalysis Letters*, *147*(8), 1882–1890.

Leng, T. Y., Mohamed, A. R., & Bhatia, S. (1999). Catalytic Conversion of Palm Oil to Fuels and Chemicals. *The Canadian Journal of Chemical Engineering*, *77*, 156–162.

Li, C., Han, X., Gong, J., Su, W., Xi, Z., Zhang, J., Wang, Q., & Xie, H. (2020). Impact of waste cooking oil on the viscosity , microstructure and mechanical performance of warm-mix epoxy asphalt binder. *Construction and Building Materials*, *251*, 118994.

Li, G., Zhang, F., Chen, L., Zhang, C., Huang, H., & Li, X. (2015). Highly Selective Hydrodecarbonylation of Oleic Acid into n-Heptadecane over a Supported Nickel/Zinc Oxide – Alumina Catalyst. *ChemCatChem*, *7*, 2646–2653.

Li, L., Quan, K., Xu, J., Liu, F., Liu, S., Yu, S., Xie, C., Zhang, B., & Ge, X. (2014). Liquid hydrocarbon fuels from catalytic cracking of rubber seed oil using USY as catalyst. *Fuel*, *123*, 189–193.

Li, Q., Sui, Z., Zhou, X., Zhu, Y., Zhou, J., & Chen, D. (2011). Coke Formation on Pt – Sn / Al2O3 Catalyst in Propane Dehydrogenation : Coke Characterization and Kinetic Study. *Topics in Catalysis*, *54*(September), 888–896.

Li, W., Gao, Y., Yao, S., Ma, D., & Yan, N. (2015). Effective deoxygenation of fatty

acids over Ni(OAc)2 in the absence of H2 and solvent. *Green Chemistry*, *17*(8), 4198–4205.

Li, W., Yang, K., Peng, J., Zhang, L., Guo, S., & Xia, H. (2008). Effects of carbonization temperatures on characteristics of porosity in coconut shell chars and activated carbons derived from carbonized coconut shell chars. *Industrial Crops and Products*, *28*, 190–198.

Li, X., Luo, X., Jin, Y., Li, J., Zhang, H., Zhang, A., & Xie, J. (2018). Heterogeneous sulfur-free hydrodeoxygenation catalysts for selectively upgrading the renewable bio-oils to second generation biofuels. *Renewable and Sustainable Energy Reviews*, *82*(November 2017), 3762–3797.

Li, X., Yan, B., Yao, S., Kattel, S., Chen, J. G., & Wang, T. (2018). Oxidative dehydrogenation and dry reforming of n-butane with CO2 over NiFe bimetallic catalysts. *Applied Catalysis B: Environmental*, *231*(March), 213–223.

Li, X., Zhang, X., Shao, S., Dong, L., Zhang, J., Hu, C., & Cai, Y. (2018). Catalytic upgrading of pyrolysis vapor from rape straw in a vacuum pyrolysis system over La / HZSM-5 with hierarchical structure. *Bioresource Technology*, *259*, 191–197.

Li, Z., Huang, Z., Ding, S., Li, F., Wang, Z., Lin, H., & Chen, C. (2018). Catalytic conversion of waste cooking oil to fuel oil : Catalyst design and effect of solvent. *Energy*, *157*, 270–277.

Lima, D. G., Soares, V. C. D., Ribeiro, E. B., Carvalho, D. A., Cardoso, É. C. V., Rassi, F. C., Mundim, K. C., Rubim, J. C., & Suarez, P. A. Z. (2004). Diesel-like fuel obtained by pyrolysis of vegetable oils. *Journal of Analytical and Applied Pyrolysis*, *71*(2), 987–996.

Looney, B. (2020). *Statistical Review of World Energy*. bp.com/statisticalreview

Lou, Y., He, P., Zhao, L., & Song, H. (2016). Refinery oil upgrading under methane environment over PdOx/H-ZSM-5 : Highly selective olefin cyclization. *Fuel*, *183*, 396–404.

Lup, A. N. K., Abnisa, F., Daud, W. M. A. W., & Aroua, M. K. (2017a). A review on reaction mechanisms of metal-catalyzed deoxygenation process in bio-oil model compounds. *Applied Catalysis A, General*, *541*, 87–106.

Lup, A. N. K., Abnisa, F., Daud, W. M. A. W., & Aroua, M. K. (2017b). A review on reactivity and stability of heterogeneous metal catalysts for deoxygenation of bio-oil model compounds. *Journal of Industrial and Engineering Chemistry*, *56*, 1–34.

Lycourghiotis, S., Kordouli, E., Sygellou, L., Bourikas, K., & Kordulis, C. (2019). Nickel catalysts supported on palygorskite for transformation of waste cooking oils into green diesel. *Applied Catalysis B: Environmental*, *259*(February), 118059.

Mahdi, H. I., Bazargan, A., McKay, G., Azelee, N. I. W., & Meili, L. (2021). Catalytic deoxygenation of palm oil and its residue in green diesel production: A current technological review. *Chemical Engineering Research and Design*, *174*, 158–187.

Maki-Arvela, P., Kubickova, I., Snåre, M., Eranen, K., Murzin, D. Y., Uni, V., Turku, F.-, & September, R. V. (2007). Catalytic Deoxygenation of Fatty Acids and Their Derivatives. *Energy and Fuels*, *21*, 30–41.

Maki-Arvela, P., Rozmyslowicz, B., Lestari, S., Simakova, O., Eranen, K., Salmi, T., & Murzin, D. Y. (2011). Catalytic Deoxygenation of Tall Oil Fatty Acid over Palladium Supported on Mesoporous Carbon. *Energy and Fuels*, *25*, 2815–2825.

Malins, K. (2021). Synthesis of renewable hydrocarbons from vegetable oil feedstock by hydrotreatment over selective sulfur-free SiO2-Al2O3 supported monometallic Pd, Pt, Ru, Ni, Mo and bimetallic NiMo catalysts. *Fuel*, *285*, 119129.

Maluangnont, T., Dararat, C., Kulrat, T., Soontontaweesub, S., Anothaiwalaikul, T., Bunprechawong, P., Chanda, R., Kanchanawarin, J., … Sooknoi, T. (2017). Production of liquid fuel from palmitic acid over nanocrystalline CeO2-based catalysts with minimal use of H2. *Catalysis Communications*, *102*(August), 123–126.

Maneechakr, P., & Karnjanakom, S. (2021). Improving the Bio-Oil Quality via Effective Pyrolysis/Deoxygenation of Palm Kernel Cake over a Metal (Cu, Ni, or Fe)-Doped Carbon Catalyst. *ACS Omega*, *6*(30), 20006–20014.

Manfrin, J., Gonçalves Jr, A. C., Schwantes, D., Conradi Jr, E., Zimmermann, J., & Ziemer, G. L. (2021). Development of biochar and activated carbon from cigarettes wastes and their applications in Pb2+adsorption. *Journal of Environmental Chemical Engineering*, *9*(2), 104980.

Martínez, G., Sánchez, N., Encinar, J. M., & González, J. F. (2014). Fuel properties of biodiesel from vegetable oils and oil mixtures. Influence of methyl esters distribution. *Biomass and Bioenergy*, *63*, 22–32.

Mohammad, M., Hari, T. K., Yaakob, Z., Sharma, Y. C., & Sopian, K. (2013). Overview on the production of paraffin based-biofuels via catalytic hydrodeoxygenation. *Renewable and Sustainable Energy Reviews*, *22*, 121–132.

Montes-Morán, M. A., Suárez, D., Angel Menéndez, J., & Fuente, E. (2012). The Basicity of Carbons. In *Novel Carbon Adsorbents*.

Montes-Navajas, P., Asenjo, N. G., Santamaría, R., Menéndez, R., Corma, A., & García, H. (2013). Surface area measurement of graphene oxide in aqueous solutions. *Langmuir*, *29*(44), 13443–13448.

Moreira, J. de B. D., Rezende, D. B. de, & Pasa, V. M. D. (2020). Deoxygenation of Macauba acid oil over Co-based catalyst supported on activated biochar from Macauba endocarp: A potential and sustainable route for green diesel and biokerosene production. *Fuel*, *269*, 117253.

Morgan, T., Grubb, D., Santillan-Jimenez, E., & Crocker, M. (2010). Conversion of triglycerides to hydrocarbons over supported metal catalysts. *Topics in Catalysis*, *53*(11–12), 820–829.

Morgan, T., Santillan-Jimenez, E., Harman-Ware, A. E., Ji, Y., Grubb, D., & Crocker,

M. (2012). Catalytic deoxygenation of triglycerides to hydrocarbons over supported nickel catalysts. *Chemical Engineering Journal*, *189–190*, 346–355.

Moulder, J. F., & Chastain, J. (1992). *Handbook of X-ray Photoelectron Spectroscopy: A Reference Book of Standard Spectra for Identification and Interpretation of XPS Data*. Physical Electronics Division, Perkin-Elmer Corporation.

Mukai, D., Tochiya, S., Murai, Y., Imori, M., Hashimoto, T., Sugiura, Y., & Sekine, Y. (2013). Role of support lattice oxygen on steam reforming of toluene for hydrogen production over Ni/La0.7Sr0.3AlO3−ı catalyst. *Applied Catalysis A : General*, *453*, 60–70.

Nam, L. T. H., Vinh, T. Q., Loan, N. T. T., Tho, V. D. S., Yang, X., & Su, B.-L. (2011). Preparation of bio-fuels by catalytic cracking reaction of vegetable oil sludge. *Fuel*, *90*(3), 1069–1075.

Narasimharao, K., Lee, A., & Wilson, K. (2007). Catalysts in production of biodiesel: A review. *Journal of Biobased Materials and Bioenergy*, *1*, 1–12.

Neonufa, G. F., Soerawidjaja, T. H., & Prakoso, T. (2017). Catalytic and Thermal Decarboxylation of Mg-Zn Basic Soap to Produce Drop-in Fuel in Diesel Boiling Ranges. *Journal of Engineering and Technology Science*, *49*, 575–586.

Nikolopoulos, I., Kogkos, G., Kordouli, E., Bourikas, K., Kordulis, C., & Lycourghiotis, A. (2020). Waste cooking oil transformation into third generation green diesel catalyzed by nickel – Alumina catalysts. *Molecular Catalysis*, *482*, 110697.

Nimkarde, M. R., & Vaidya, P. D. (2016). Toward Diesel Production from Karanja Oil Hydrotreating over CoMo and NiMo Catalysts. *Energy and Fuels*, *30*(4), 3107–3112.

Oh, S., Lee, J. H., Choi, I.-G., & Choi, J. W. (2020). Enhancement of bio-oil hydrodeoxygenation activity over Ni-based bimetallic catalysts supported on SBA-15. *Renewable Energy*, *149*, 1–10.

Oi, L. E., Choo, M., Lee, H. V., Taufiq-yap, Y. H., Cheng, C. K., & Juan, J. C. (2020). Catalytic deoxygenation of triolein to green fuel over mesoporous TiO2 aided by in situ hydrogen production. *International Journal of Hydrogen Energy*, *45*(20), 11605–11614.

Ong, Y. K., & Bhatia, S. (2010). The current status and perspectives of biofuel production via catalytic cracking of edible and non-edible oils. *Energy*, *35*(1), 111–119.

Ooi, X. Y., Gao, W., Ong, H. C., Lee, H. V., Juan, J. C., Chen, W. H., & Lee, K. T. (2019). Overview on catalytic deoxygenation for biofuel synthesis using metal oxide supported catalysts. *Renewable and Sustainable Energy Reviews*, *112*(December 2018), 834–852.

Osorio-vargas, P., Flores-González, N. A., Navarro, R. M., Fierro, J. L. G., Campos, C. H., & Reyes, P. (2015). Improved stability of Ni/Al2O3 catalysts by effect of promoters (La2O3 , CeO2) for ethanol steam-reforming reaction. *Catalysis Today*,

259, 27–38.

Papageridis, K. N., Charisiou, N. D., Douvartzides, S. L., Sebastian, V., Hinder, S. J., Baker, M. A., Alkhoori, S., Polychronopoulou, K., & Goula, M. A. (2020). Effect of operating parameters on the selective catalytic deoxygenation of palm oil to produce renewable diesel over Ni supported on Al2O3 , ZrO2 and SiO2 catalysts. *Fuel Processing Technology*, *209*, 106547.

Papageridis, K. N., Charisiou, N. D., Douvartzides, S., Sebastian, V., Hinder, S. J., Baker, M. A., AlKhoori, A. A., AlKhoori, S. I., … Goula, M. A. (2021). Continuous selective deoxygenation of palm oil for renewable diesel production over Ni catalysts supported on Al2O3 and La2O3-Al2O3. *RSC Advances*, *11*(15), 8569–8584.

Papageridis, K. N., Charisiou, N. D., Douvartzides, S., Sebastian, V., Hinder, S. J., Baker, M. A., AlKhoori, S., Polychronopoulou, K., & Goula, M. A. (2020). Promoting effect of CaO-MgO mixed oxide on Ni/γ-Al2O3 catalyst for selective catalytic deoxygenation of palm oil. *Renewable Energy*, *162*, 1793–1810.

Patel, M., & Kumar, A. (2016). Production of renewable diesel through the hydroprocessing of lignocellulosic biomass-derived bio-oil : A review. *Renewable and Sustainable Energy Reviews*, *58*, 1293–1307.

Patil, S. J., & Vaidya, P. D. (2018). Production of Hydrotreated Jatropha Oil Using Co-Mo and Ni-Mo Catalysts and Its Blending with Petroleum Diesel. *Energy and Fuels*, *32*(2), 1812–1821.

Pattanaik, B. P., & Misra, R. D. (2017). Effect of reaction pathway and operating parameters on the deoxygenation of vegetable oils to produce diesel range hydrocarbon fuels: A review. *Renewable and Sustainable Energy Reviews*, *73*, 545–557.

Peng, B., Yao, Y., Zhao, C., & Lercher, J. A. (2012). Towards Quantitative Conversion of Microalgae Oil to Diesel-Range Alkanes with Bifunctional Catalysts. *Angewandte Communications*, *51*, 2072–2075.

Peng, B., Zhao, C., Kasakov, S., Foraita, S., & Lercher, J. A. (2013). Manipulating Catalytic Pathways : Deoxygenation of Palmitic Acid on Multifunctional Catalysts. *Chemistry A European Journal*, *19*, 4732–4741.

Phan-Vu, D.-H., & Tan, C.-S. (2017). Synthesis of phthalate-free plasticizers by hydrogenation in water using RhNi bimetallic catalyst on aluminated SBA-15. *RSC Advances*, *7*(30), 18178–18188.

Phimsen, S., Kiatkittipong, W., Yamada, H., Tagawa, T., Kiatkittipong, K., Laosiripojana, N., & Assabumrungrat, S. (2017). Nickel sulfide, nickel phosphide and nickel carbide catalysts for bio-hydrotreated fuel production. *Energy Conversion and Management*, *151*, 324–333.

Priecel, P., Čapek, L., Kubička, D., Homola, F., Ryšánek, P., & Pouzar, M. (2011). The role of alumina support in the deoxygenation of rapeseed oil over NiMo-alumina catalysts. *Catalysis Today*, *176*(1), 409–412.

Qian, E. W., Chen, N., & Gong, S. (2014). Role of support in deoxygenation and isomerization of methyl stearate over nickel-molybdenum catalysts. *Journal of Molecular Catalysis A: Chemical*, *387*, 76–85.

Quah, R. V., Tan, Y. H., Mubarak, N. M., Khalid, M., Abdullah, E. C., & Nolasco-Hipolito, C. (2019). An overview of biodiesel production using recyclable biomass and non-biomass derived magnetic catalysts. *Journal of Environmental Chemical Engineering*, *7*(4), 103219.

Ramadhas, A. S., Jayaraj, S., & Muraleedharan, C. (2005). Biodiesel production from high FFA rubber seed oil. *Fuel*, *84*, 335–340.

Ramesh, A., Tamizhdurai, P., Krishnan, P. S., Ponnusamy, V. K., Sakthinathan, S., & Shanthi, K. (2020). Catalytic transformation of non-edible oils to biofuels through hydrodeoxygenation using Mo-Ni/mesoporous alumina-silica catalysts. *Fuel*, *262*, 116494.

Ramesh, A., Tamizhdurai, P., & Shanthi, K. (2019). Catalytic hydrodeoxygenation of jojoba oil to the green-fuel application on Ni-MoS / Mesoporous zirconia-silica catalysts. *Renewable Energy*, *138*, 161–173.

Rashid, U., Anwar, F., Ashraf, M., Saleem, M., & Yusup, S. (2011). Application of response surface methodology for optimizing transesterification of Moringa oleifera oil : Biodiesel production. *Energy Conversion and Management*, *52*(8–9), 3034–3042.

Ren, X., Li, J., Tan, X., & Wang, X. (2013). Comparative study of graphene oxide, activated carbon and carbon nanotubes as adsorbents for copper decontamination. *Dalton Transactions*, *42*, 5266–5274.

Renz, M. (2005). Ketonization of Carboxylic Acids by Decarboxylation : Mechanism and Scope. *European Journal of Organic Chemistry*, 979–988.

Rogers, K. A., & Zheng, Y. (2016). Selective Deoxygenation of Biomass-Derived Bio-oils within Hydrogen-Modest Environments : A Review and New Insights. *ChemSusChem*, *9*, 1750–1772.

Romero, M. J. A., Pizzi, A., Toscano, G., Busca, G., Bosio, B., & Arato, E. (2016). Deoxygenation of waste cooking oil and non-edible oil for the production of liquid hydrocarbon biofuels. *Waste Management*, *47*, 62–68.

Roussel, M., Norsic, S., Lemberton, J.-L., Guisnet, M., Cseri, T., & Benazzi, E. (2005). Hydrocracking of n-decane on a bifunctional sulfided NiW/silica – alumina catalyst : effect of the operating conditions. *Applied Catalysis A: General*, *279*, 53–58.

Rozmyslowicz, B., Maki-Arvela, P., Tokarev, A., Leino, A., Eranen, K., & Murzin, D. Y. (2012). Influence of Hydrogen in Catalytic Deoxygenation of Fatty Acids and Their Derivatives over Pd / C. *Industrial & Engineering Chemistry Research*, *51*, 8922–8927.

Sahoo, S. K., Ray, S. S., & Singh, I. D. (2004). Structural characterization of coke on

spent hydroprocessing catalysts used for processing of vacuum gas oils. *Applied Catalysis A : General*, *278*, 83–91.

Sangar, S. K., Syazwani, O. N., Farabi, M. S. A., Razali, S. M., Shobhana, G., Teo, S. H., & Taufiq-Yap, Y. H. (2019). Effective biodiesel synthesis from palm fatty acid distillate (PFAD) using carbon-based solid acid catalyst derived glycerol. *Renewable Energy*, *142*, 658–667.

Sanli, H., Canakci, M., & Alptekin, E. (2011). Characterization of Waste Frying Oils Obtained from Different Facilities. *Bioenergy Technology*, 479–485.

Santillan-Jimenez, E., & Crocker, M. (2012). Catalytic deoxygenation of fatty acids and their derivatives to hydrocarbon fuels via decarboxylation/decarbonylation. *Journal of Chemical Technology and Biotechnology*, *87*(8), 1041–1050.

Santillan-Jimenez, E., Morgan, T., Lacny, J., Mohapatra, S., & Crocker, M. (2013). Catalytic deoxygenation of triglycerides and fatty acids to hydrocarbons over carbon-supported nickel. *Fuel*, *103*, 1010–1017.

Sari, E. (2013). Green Diesel Production via Catalytic Hydrogenation/Decarboxylation of Triglycerides and Fatty Acids of Vegetable Oil and Brown Grease. In *Wayne State University*.

Sari, E., Dimaggio, C., Kim, M., Salley, S. O., & Ng, K. Y. S. (2013). Catalytic conversion of brown grease to green diesel via decarboxylation over activated carbon supported palladium catalyst. *Industrial and Engineering Chemistry Research*, *52*(33), 11527–11536.

Satyarthi, J. K., & Srinivas, D. (2011). Fourier Transform Infrared Spectroscopic Method for Monitoring Hydroprocessing of Vegetable Oils To Produce Hydrocarbon-Based Biofuel. *Energy and Fuels*, *25*, 3318–3322.

Sawangkeaw, R., & Ngamprasertsith, S. (2013). A review of lipid-based biomasses as feedstocks for biofuels production. *Renewable and Sustainable Energy Reviews*, *25*, 97–108.

Sehested, J., Gelten, J. A. P., & Helveg, S. (2006). Sintering of nickel catalysts : Effects of time , atmosphere , temperature , nickel-carrier interactions , and dopants. *Applied Catalysis A : General*, *309*, 237–246.

Shamsuddin, M. R., Asikin-Mijan, N., Marliza, T. S., Miyamoto, M., Uemiya, S., Yarmo, M. A., & Taufiq-Yap, Y. H. (2021). Promoting dry reforming of methane via bifunctional NiO/dolomite catalysts for production of hydrogen-rich syngas. *RSC Advances*, *11*(12), 6667–6681.

Shimada, I., Kato, S., Hirazawa, N., Nakamura, Y., Ohta, H., Suzuki, K., & Takatsuka, T. (2017). Deoxygenation of Triglycerides by Catalytic Cracking with Enhanced Hydrogen Transfer Activity. *Industrial & Engineering Chemistry Research*, *56*, 75–86.

Shin, S. I., Go, A., Kim, I. Y., Lee, J. M., Lee, Y., & Hwang, S.-J. (2013). A beneficial role of exfoliated layered metal oxide nanosheets in optimizing the electrocatalytic

activity and pore structure of Pt-reduced graphene oxide nanocomposites. *Energy and Environmental Science*, *6*(2), 608–617.

Sidek, H. B. M., Jo, Y. K., Kim, I. Y., & Hwang, S.-J. (2016). Stabilization of Layered Double Oxide in Hybrid Matrix of Graphene and Layered Metal Oxide Nanosheets: An Effective Way to Explore Efficient CO2 Adsorbent. *Journal of Physical Chemistry C*, *120*(41), 23421–23429.

Singh, D., Sandhu, S. S., & Sarma, A. K. (2018). An investigation of green diesel produced through hydro-processing of waste cooking oil using an admixture of two heterogeneous catalysts. *Energy Sources, Part A: Recovery, Utilization and Environmental Effects*, *40*(8), 968–976.

Singh, H. K. G., Yusup, S., Quitain, A. T., Abdullah, B., Ameen, M., Sasaki, M., Kida, T., & Cheah, K. W. (2020). Biogasoline production from linoleic acid via catalytic cracking over nickel and copper-doped ZSM-5 catalysts. *Environmental Research*, *186*(April), 109616.

Snåre, M., Kubičková, I., Mäki-Arvela, P., Chichova, D., Eränen, K., & Murzin, D. Y. (2008). Catalytic deoxygenation of unsaturated renewable feedstocks for production of diesel fuel hydrocarbons. *Fuel*, *87*(6), 933–945.

Snåre, M., Kubičková, I., Mäki-Arvela, P., Eränen, K., & Murzin, D. Y. (2006). Heterogeneous Catalytic Deoxygenation of Stearic Acid for Production of Biodiesel. *Industrial & Engineering Chemistry Research*, *45*(16), 5708–5715.

Snåre, M., Kubičková, I., Mäki-Arvela, P., Eränen, K., Wärnå, J., & Murzin, D. Y. (2007). Production of diesel fuel from renewable feeds: Kinetics of ethyl stearate decarboxylation. *Chemical Engineering Journal*, *134*(1–3), 29–34.

Snåre, M., Mäki-Arvela, P., Simakova, I. L., Myllyoja, J., & Murzin, D. Y. (2009). Overview of catalytic methods for production of next generation biodiesel from natural oils and fats. *Russian Journal of Physical Chemistry B*, *3*(7), 1035–1043.

Sonthalia, A., & Kumar, N. (2017). Hydroprocessed vegetable oil as a fuel for transportation sector: A review. *Journal of the Energy Institute*, *92*(1), 1–17.

Sourmehi, C. (2021). *Today Energy*. U.S.Energy Information Administration. https://www.eia.gov/todayinenergy/detail.php?id=49876

Srifa, A., Faungnawakij, K., Itthibenchapong, V., & Assabumrungrat, S. (2015). Roles of monometallic catalysts in hydrodeoxygenation of palm oil to green diesel. *Chemical Engineering Journal*, *278*, 249–258.

Sugami, Y., Minami, E., & Saka, S. (2016). Renewable diesel production from rapeseed oil with hydrothermal hydrogenation and subsequent decarboxylation. *Fuel*, *166*, 376–381.

Sun, H., Abdeta, A. B., Kuo, D.-H., Wu, Q., Guo, Y., Ahmed Zelekew, O., Yuan, Z., Lin, J., & Chen, X. (2021). Activated carbon supported CuSnOS catalyst with an efficient catalytic reduction of pollutants under dark condition. *Journal of Molecular Liquids*, *334*, 116079.

Sun, K., Schulz, T. C., Thompson, S. T., & Lamb, H. H. (2016). Catalytic deoxygenation of octanoic acid over silica- and carbon-supported palladium : Support effects and reaction pathways. *Catalysis Today*, *269*, 93–102.

Tamura, M., Tonomura, T., Shimizu, K., & Satsuma, A. (2012). CeO2-catalysed one-pot selective synthesis of esters from nitriles and alcohols. *Green Chemistry*, *14*, 984–991.

Tan, C.-Y., & Tsai, W.-T. (2015). Effects of Ni and Co-decorated MWCNTs addition on the dehydrogenation behavior and stability of LiAlH4. *International Journal of Hydrogen Energy*, *40*(40), 14064–14071.

Taufiq-Yap, Y. H., Lee, H. V., Yunus, R., & Juan, J. C. (2011). Transesterification of non-edible Jatropha curcas oil to biodiesel using binary Ca-Mg mixed oxide catalyst: Effect of stoichiometric composition. *Chemical Engineering Journal*, *178*, 342–347.

Taufiqurrahmi, N., Mohamed, A. R., & Bhatia, S. (2010). Deactivation and coke combustion studies of nanocrystalline zeolite beta in catalytic cracking of used palm oil. *Chemical Engineering Journal*, *163*(3), 413–421.

Taufiqurrahmi, N., Mohamed, A. R., & Bhatia, S. (2011). Nanocrystalline zeolite beta and zeolite Y as catalysts in used palm oil cracking for the production of biofuel. *Journal of Nanoparticle Research*, *13*, 3177–3189.

Thalgaspitiya, W. R. K., Kapuge, T. K., He, J., Deljoo, B., Meguerdichian, A. G., Aindow, M., & Suib, S. L. (2020). Multifunctional transition metal doped titanium dioxide reduced graphene oxide composites as highly efficient adsorbents and photocatalysts. *Microporous and Mesoporous Materials*, *307*(April), 110521.

Thongkumkoon, S., Kiatkittipong, W., Wetwatana, U., Laosiripojana, N., & Daorattanachai, P. (2019). Catalytic activity of trimetallic sulfided Re-Ni-Mo / g - Al 2 O 3 toward deoxygenation of palm feedstocks. *Renewable Energy*, *140*, 111–123.

Tian, Q., Zhang, Z., Zhou, F., Chen, K., Fu, J., Lu, X., & Ouyang, P. (2017). Role of Solvent in Catalytic Conversion of Oleic Acid to Aviation Biofuels. *Energy and Fuels*, *31*(6), 6163–6172.

Trisunaryanti, W., Wijaya, K., Triyono, T., Adriani, A. R., & Larasati, S. (2021). Green synthesis of hierarchical porous carbon prepared from coconut lumber sawdust as Ni-based catalyst support for hydrotreating Callophyllum inophyllum oil. *Results in Engineering*, *11*, 100258.

Tsai, W.-T., Lin, C.-C., & Yeh, C.-W. (2007). An analysis of biodiesel fuel from waste edible oil in Taiwan. *Renewable and Sustainable Energy Reviews*, *11*, 838–857.

Twaiq, F. A. A., Mohamad, A. R., & Bhatia, S. (2004). Performance of composite catalysts in palm oil cracking for the production of liquid fuels and chemicals. *Fuel Processing Technology*, *85*, 1283–1300.

U. S. Energy Information Administration. (2021).

Veriansyah, B., Han, J. Y., Kim, S. K., Hong, S. A., Kim, Y. J., Lim, J. S., Shu, Y. W., Oh, S. G., & Kim, J. (2012). Production of renewable diesel by hydroprocessing of soybean oil: Effect of catalysts. *Fuel*, *94*, 578–585.

Vyas, A. P., Verma, J. L., & Subrahmanyam, N. (2010). A review on FAME production processes. *Fuel*, *89*(1), 1–9.

Wan, G., Duan, A., Zhang, Y., Zhao, Z., Jiang, G., Zhang, D., Gao, Z., Liu, J., & Chung, K. H. (2009). Hydrodesulfurization of fluidized catalytic cracking diesel oil over NiW/AMB catalysts containing h-type β-zeolite in situ synthesized from kaolin material. *Energy and Fuels*, *23*(8), 3846–3852.

Wang, C., & Astruc, D. (2018). Recent developments of metallic nanoparticle-graphene nanocatalysts. *Progress in Materials Science*, *94*, 306–383.

Wang, H., Li, G., Rogers, K., Lin, H., Zheng, Y., & Ng, S. (2017). Hydrotreating of waste cooking oil over supported CoMoS catalyst – Catalyst deactivation mechanism study. *Molecular Catalysis*, *443*, 228–240.

Wang, J., Fan, G., & Li, F. (2012). Carbon-supported Ni catalysts with enhanced metal dispersion and catalytic performance for hydrodechlorination of chlorobenzene. *RSC Advances*, *2*(26), 9976–9985.

Wang, S., & Lu, G. Q. M. (1998). Role of CeO2 in Ni/CeO2 - Al2O3 catalysts for carbon dioxide reforming of methane. *Applied Catalysis B: Environmental 19*, *19*, 267–277.

Wang, Y., Wang, J., Fan, G., & Li, F. (2012). Synthesis of a novel Ni/C catalyst derived from a composite precursor for hydrodechlorination. *Catalysis Communications*, *19*, 56–60.

Wang, Z., Cao, X.-M., Zhu, J., & Hu, P. (2014). Activity and coke formation of nickel and nickel carbide in dry reforming : A deactivation scheme from density functional theory. *Journal of Catalysis*, *311*, 469–480.

Xin, H., Guo, K., Li, D., Yang, H., & Hu, C. (2016). Production of high-grade diesel from palmitic acid over activated carbon-supported nickel phosphide catalysts. *Applied Catalysis B: Environmental*, *187*, 375–385.

Xing, S., Lv, P., Zhao, C., Li, M., Yang, L., Wang, Z., Chen, Y., & Liu, S. (2018). Solvent-free catalytic deoxygenation of oleic acid via nano-Ni/HZSM-5 : Effect of reaction medium and coke characterization. *Fuel Processing Technology*, *179*, 324–333.

Yaakob, Z., Mohammad, M., Alherbawi, M., Alam, Z., & Sopian, K. (2013). Overview of the production of biodiesel from Waste cooking oil. *Renewable and Sustainable Energy Reviews*, *18*, 184–193.

Yehliu, K., Boehman, A. L., & Armas, O. (2010). Emissions from different alternative diesel fuels operating with single and split fuel injection. *Fuel*, *89*(2), 423–437.

Yenumala, S. R., Maity, S. K., & Shee, D. (2016). Hydrodeoxygenation of Karanja Oil

over Supported Nickel Catalysts: Influence of Support and Nickel Loading. *Catalysis Science & Technology*, *6*, 3156–3165.

Yoosuk, B., Udomsap, P., & Puttasawat, B. (2011). Hydration-dehydration technique for property and activity improvement of calcined natural dolomite in heterogeneous biodiesel production: Structural transformation aspect. *Applied Catalysis A: General*, *395*(1–2), 87–94.

Zhang, Y., Duan, D., Lei, H., Villota, E., & Ruan, R. (2019). Jet fuel production from waste plastics via catalytic pyrolysis with activated carbons. *Applied Energy*, *251*(May), 113337.

Zhao, J., Wang, G., Qin, L., Li, H., Chen, Y., & Liu, B. (2016). Synthesis and catalytic cracking performance of mesoporous zeolite Y. *Catalysis Communications*, *73*, 98–102.

Zhao, X., Wei, L., Cheng, S., & Julson, J. (2017). Review of Heterogeneous Catalysts for Catalytically Upgrading Vegetable Oils into Hydrocarbon Biofuels. *Catalysts*, *7*, 1–25.

Zheng, Y., Wang, F., Yang, X., Huang, Y., Liu, C., Zheng, Z., & Gu, J. (2017). Study on aromatics production via the catalytic pyrolysis vapor upgrading of biomass using metal-loaded modified H-ZSM-5. *Journal of Analytical and Applied Pyrolysis*, *126*, 169–179.

Zulkepli, S., Juan, J. C., Lee, H. V., Rahman, N. S. A., Show, P. L., & Ng, E. P. (2018). Modified mesoporous HMS supported Ni for deoxygenation of triolein into hydrocarbon-biofuel production. *Energy Conversion and Management*, *165*, 495–508.