Analysis of Catalytic Hydrothermal Liquefaction

A Major Qualifying Project
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ABSTRACT

This report investigates the efficacy of Catalytic Hydrothermal Liquefaction (CHTL) as a sustainable method for converting biomass and waste into biocrude oil. The analysis encompasses a comprehensive review and synthesis of data from 57 scholarly articles, focusing on diverse feedstocks and catalytic conditions to optimize biocrude yield. Key parameters such as reaction temperature, time, and catalyst type were critically examined to determine their impact on the efficiency of biocrude production. Findings reveal that CHTL can effectively handle a variety of feedstock types, including municipal and industrial waste, with the incorporation of catalysts enhancing both yield and quality of the biocrude. This process presents a promising pathway for the generation of renewable energy, aligning with environmental sustainability goals by offering an alternative to fossil fuels and contributing to waste reduction. Recommendations for future research include the development of more robust catalysts and the standardization of reporting parameters to enhance the comparability of CHTL studies. This study substantiates CHTL's potential in contributing to sustainable energy solutions and advancing the field of chemical engineering.

ACKNOWLEDGEMENT

I would like to thank my advisor, Professor Michael Timko from the Chemical Engineering department, for his guidance and support throughout this project. I would also like to thank Professor Aidin Panahi and David Kenney for their helpful discussions.

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CHAPTER 1: INTRODUCTION

1.1 Waste and its Multidimensional Impact

The mere mention of "waste" might conjure up images of overflowing bins and discarded materials, signaling the end of their utility. Yet, the repercussions of waste accumulation permeate deeper, casting long shadows over our environment, economy, and societal well-being. A poignant illustration of these broad impacts can be seen through the lens of Beijing's air quality crisis in the mid-2010s, a period marked by hazardous smog levels that not only obscured the city's skyline but also the health and livelihoods of its residents.

In Beijing, the dense smog, primarily a byproduct of rampant fossil fuel consumption and exacerbated by inefficient waste handling, reached alarming levels. The air quality deteriorated to such an extent that it often breached the "red" threshold, signaling immediate health hazards. The palpable haze enveloping the city served as a stark reminder of the environmental degradation stemming from unchecked waste production and energy consumption. The smog's persistence had tangible economic ramifications. Tourist arrivals dwindled as images of a city shrouded in pollution dominated media coverage worldwide. The government, in an effort to mitigate the crisis, imposed stringent measures including the temporary shutdown of factories. While these actions were necessary for public health, they inadvertently led to economic strain, highlighting the intricate balance between environmental policy and economic stability. Perhaps most telling was the social disruption caused by the smog. On several occasions, the air quality was deemed so hazardous that schools were compelled to close, urging students to stay home - a measure rarely taken, underscoring the severity of the situation. This isolation, coupled with the public's growing apprehension towards outdoor activities, fostered a climate of social detachment, as face-to-face interactions diminished and communities reeled under the weight of environmental anxiety. This scenario in Beijing is a microcosm of a global challenge, where the legacy of waste - its generation, mismanagement, and the quest for disposal - clashes with the pillars of sustainable development. The incident underscores an urgent need for innovative waste management solutions that not only address the immediate environmental concerns but also weave in economic viability and social harmony.

1.2 The Challenges of Waste Accumulation

Unmanaged waste accumulation presents a formidable challenge to ecological stability and public health. In the absence of effective waste management and recycling initiatives, landfills continue to expand, gradually transforming vast tracts of land into repositories of waste. This scenario not only diminishes the aesthetic and utility value of the landscape but also poses significant environmental threats. As the global population surges, the volume of waste generated similarly escalates, exacerbating the strain on already overburdened waste disposal systems. Such an accumulation is not just an environmental and health concern but a clarion call for the adoption of sustainable waste management practices. The need for innovative approaches to waste reduction, reuse, and recycling has never been more pressing. As we confront the realities of a finite planet, the transition towards a circular economy, where waste is not merely disposed of but reimagined as a resource, becomes imperative.

1.3 The Cost of Energy Consumption

The paradigm of energy consumption, as outlined by the U.S. Energy Information Administration (EIA), underscores a dependency on a mix of energy sources: petroleum, natural gas, nuclear power, coal, and renewable energy. Notably, the fossil fuels among these - petroleum, natural gas, and coal - account for approximately 80% of total energy consumption.(EIA, 2022) The finite nature of these resources underscores a pressing concern: not only are they non-renewable, necessitating extended periods to replenish, but their dominance in our energy portfolio perpetuates a cycle of environmental degradation and waste generation.

The environmental repercussions of relying on fossil fuels are profound and multifaceted. The combustion process releases a slew of pollutants, including carbon dioxide, nitrogen oxides, sulfur oxides, and heavy metals - contaminants that have been linked to a range of health hazards, from respiratory ailments to cardiovascular diseases. These emissions contribute to the exacerbation of acid rain, and air quality deterioration, presenting severe challenges to environmental sustainability and public health.

Transitioning towards renewable energy sources emerges as a critical solution to this conundrum. Renewable energy, characterized by its ability to regenerate quickly and its minimal environmental footprint, offers a path to reduce reliance on fossil fuels, thereby mitigating the associated waste and pollution issues. The adoption of renewable energy plays a pivotal role in curbing the production of hazardous waste, marking a significant step towards sustainable energy consumption and environmental stewardship.

1.4 Purpose of The Project

In the realm of chemical engineering, confronting the challenges posed by waste accumulation and energy sustainability is paramount. A critical part of this endeavor involves not only the reimagining of waste as a valuable resource but also the exploration of efficient methods for its conversion into energy. Catalytic Hydrothermal Liquefaction (CHTL) stands at the forefront of this exploration, promising a transformative approach to waste management and energy production.

This project is anchored in the comprehensive analysis of hundreds of data points derived from 57 scholarly papers, each contributing unique insights into the CHTL process. By examining a diverse array of feedstocks and operating conditions, this analysis aims to distill a wealth of experimental knowledge into actionable insights. The objective is to illuminate the optimal conditions under which

CHTL can convert waste to energy most effectively, thereby maximizing its potential as a sustainable solution.

Through meticulous examination and synthesis of existing research, the project endeavors to advance the field of chemical engineering by providing a clearer understanding of CHTL's efficiency. In doing so, it seeks to pave the way for more sustainable practices in waste management and energy production, contributing to a future where waste is not an end-point but a beginning - a valuable resource for renewable energy generation.

CHAPTER 2: BACKGROUND

2.1 The Importance of Renewable Energy

Renewable energy is a swiftly replenishing source, predominantly representing clean energy forms. The Energy Information Administration (EIA) states that as of 2022, renewable energy's share of total consumption stood at 13%, a figure that, although growing, remains small compared to fossil fuel usage as Figure 1 shown. The advantages of adopting renewable energy span environmental, societal, and health domains. The United States Environmental Protection Agency (EPA) notes that renewable energy generation avoids air pollution, as it does not involve combustion or emit harmful byproducts seen with fossil fuel usage (EPA, 2015). This aspect emphasizes renewable energy's environmental benefits. Economically, the National Renewable Energy Laboratory (NREL) suggests that renewable energy sectors tend to be labor-intensive, thus generating significant employment opportunities and supporting economic expansion (NREL, 1997).

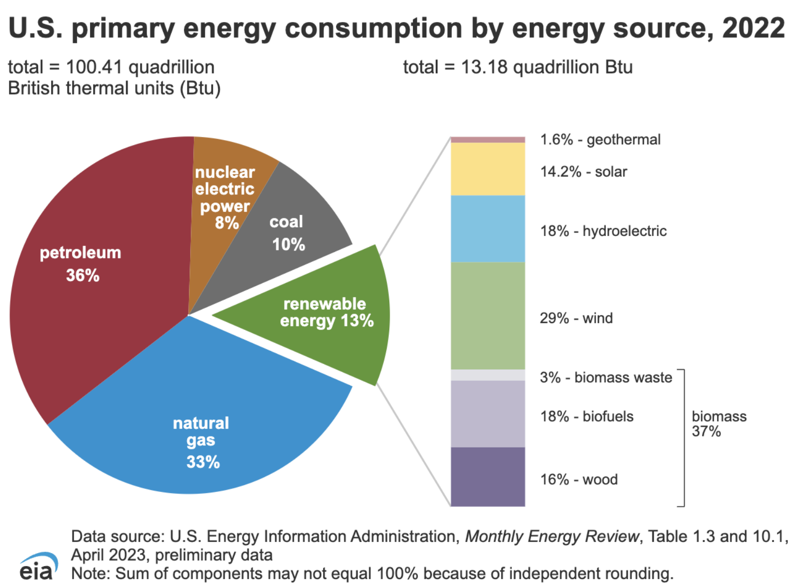

Figure 1: 2022 U.S energy consumption pie chart (EIA, 2023)

2.2 Methods of converting Waste to Energy

Several innovative methods for converting waste into energy have been developed, each employing unique processes to transform waste materials into valuable energy sources. Among these, gasification, pyrolysis, incineration, and anaerobic digestion stand out due to their distinct mechanisms and outcomes.

Gasification, as shown in Figure 2, offers a promising route by converting biomass into syngas through a process that involves high temperatures and pressures but limits combustion to reduce emissions. This syngas is a versatile intermediate that can be used to generate electricity or synthesize other useful products (NETL). Despite its advantages, gasification poses challenges such as safety risks and high energy requirements, especially since operational temperatures can reach around 700°C (Mebunii, 2022).

Pyrolysis, as shown in Figure 3, utilizes high temperatures in an oxygen-deprived environment to break down biomass into bio-oil, alongside gas and char. This process is noteworthy for its ability to reduce waste significantly and produce a liquid fuel that can be further upgraded (Zone, 2020). However, the complexity of the pyrolysis process, the necessity for regular maintenance of sophisticated equipment, and the high capital costs involved pose substantial barriers to its widespread adoption (Henan Doing Mechanical Equipment, 2019).

Incineration, as shown in Figure 4, involves the combustion of waste to destroy contaminants and generate energy in the form of heat, steam, and ash (Lam et al, 2010). While effective in reducing waste volume, the process's environmental impact, including the production of greenhouse gases and potentially toxic ash, cannot be overlooked. These emissions, containing substances such as carbon dioxide and sulfur dioxide, present significant environmental and health hazards (EQTEC, 2020).

Anaerobic digestion, as shown in Figure 5, represents a biological approach where microorganisms decompose organic matter in the absence of oxygen, producing biogas and a nutrient-rich digestate (EPA, 2019). This method is celebrated for its use of renewable resources and its contributions to improving air and water quality. Nonetheless, its application is somewhat limited to operations that can provide a steady supply of organic waste, such as large farms, underscoring the need for ongoing research to broaden its usability and efficiency (McCloy, 2023). Moreover, the process's scalability and operational nuances necessitate further exploration to optimize its benefits across different contexts.

Each method contributes uniquely to the renewable energy landscape, offering solutions to waste management challenges while also presenting specific operational, environmental, and economic hurdles. The future of waste-to-energy technologies hinges on addressing these challenges through continuous innovation, research, and development to enhance their efficiency, reduce negative impacts, and maximize their contributions to sustainable energy systems.

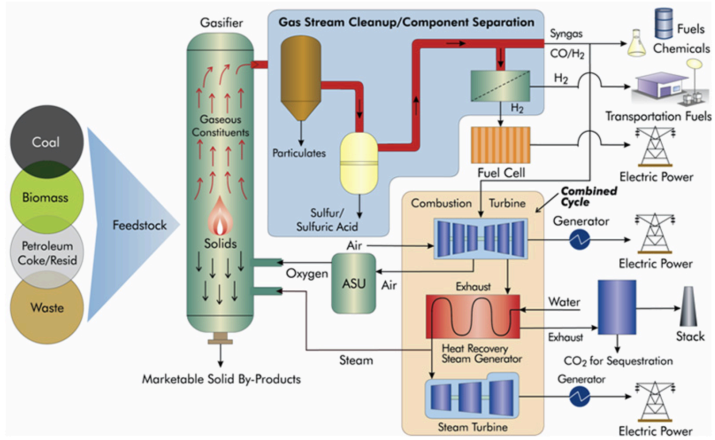

Figure 2: The gasification process, transforming coal, biomass, and waste into syngas for energy and chemical production. (NETL)

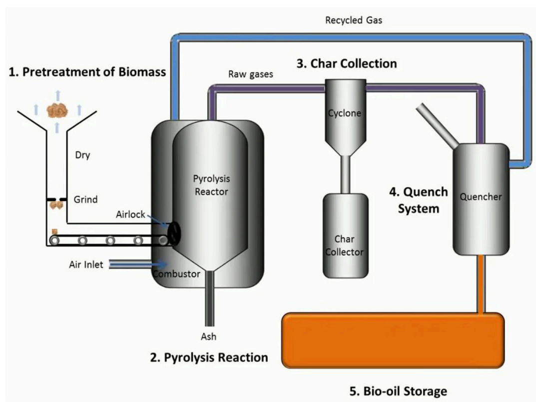

Figure 3: The pyrolysis process where biomass undergoes pretreatment with the end product being stored as bio-oil. (Zone, 2020)

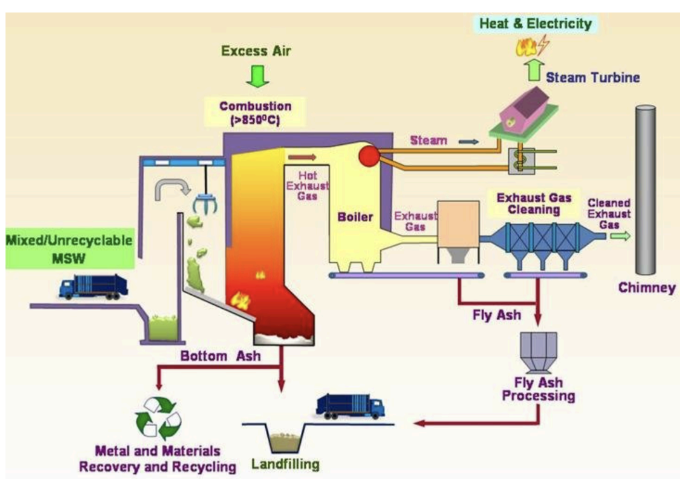

Figure 4: The incineration process for waste management.(Lam et al, 2010)

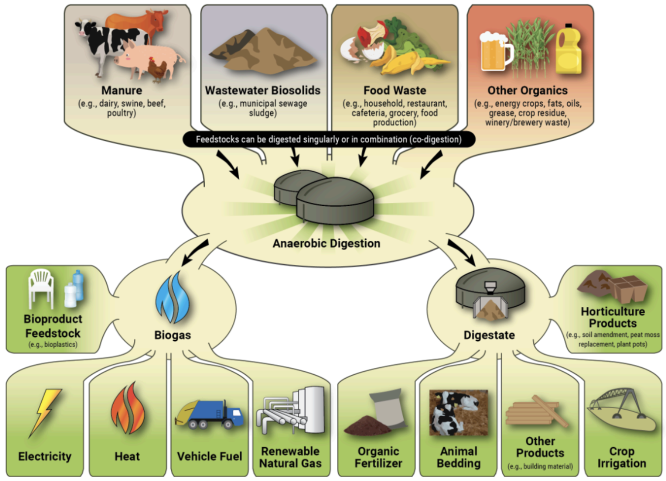

Figure 5: Anaerobic digestion process, converting various organic materials into biogas for energy and digestate for agricultural use. (EPA, 2019)

2.3 Hydrothermal Liquefaction Method

Hydrothermal liquefaction (HTL) is a thermochemical process conducted in a sealed reactor that transforms wet biomass, such as food waste and municipal sludge, into biocrude oil and chemicals under moderate temperatures (200 - 400°C) and high pressures (10 - 25 MPa) (Zhang & Chen, 2018). As Figure 6 showed, there are a variety of feedstocks that can be chosen from, like sewage sludge, food waste, industrial waste, biomass and more (Ziba et al, 2023) . Batch reactor is the most commonly used one for the hydrothermal liquefaction processes. The process consists of three main steps: hydrolysis, where biomass is broken down into smaller compounds; depolymerization and decomposition of these compounds; and finally, recombination, where they form biocrude, gasses, and solids (Rudra & Jayathilake, 2022). This process produces biocrude oil, a versatile substance that can be used to generate power and electricity. Additionally, it can be refined into various fuels, including gasoline and diesel, offering a renewable alternative to conventional fossil fuels (Goswami et al, 2019). Biocrude oil can also be directly utilized as a fuel for power generation and has the potential to be integrated into existing petroleum refineries, thus reducing the carbon footprint of traditional fuels (Sandeep et al, 2023). Ongoing research focuses on enhancing the production and conversion efficiency of biocrude oil, highlighting its significant role in the renewable energy sector. The ability to produce biocrude from diverse biomass sources adds to its appeal, marking it as a crucial component in the transition towards sustainable energy solutions.

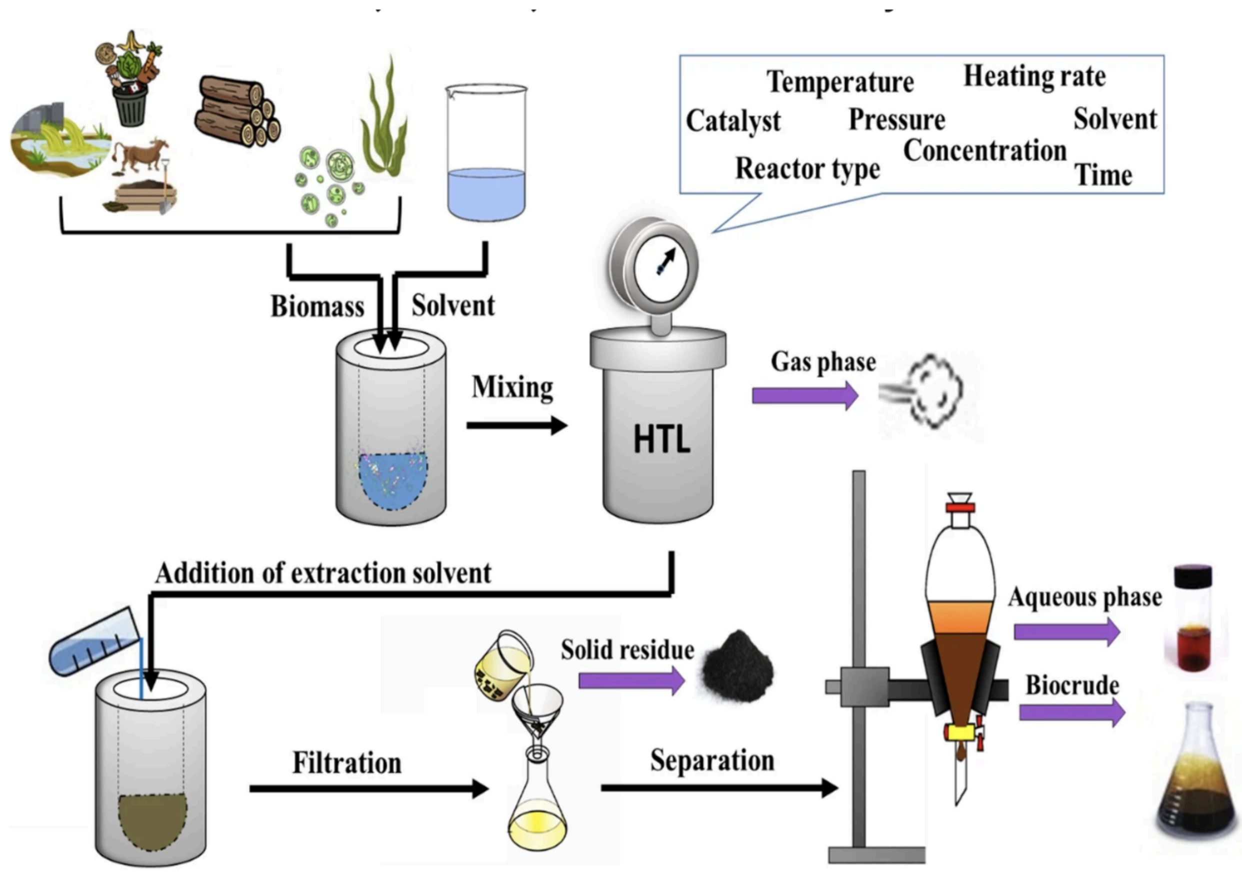

Figure 6: Hydrothermal liquefaction process, detailing the transformation of diverse biomass into biocrude through solvent mixing, high-temperature and high-pressure reaction, and subsequent phase separation. (Zhang & Chen, 2018)

2.4 Challenges of Hydrothermal Liquefaction

Hydrothermal Liquefaction (HTL) is a promising technology for converting biomass into bio-oil, yet it faces multiple technical and operational challenges that limit its broader adoption. One of the primary concerns is the quality of the bio-oil produced, which often contains a high level of impurities such as ash and heteroatoms (nitrogen, sulfur, and oxygen), making the oil less desirable for further applications. These impurities require extensive refining processes, including hydrotreating and catalytic cracking, to upgrade the bio-oil to a quality compatible with conventional fuels. Such refining processes significantly increase both the complexity and the cost of production (Ghadge et al, 2022).

The nature of the biomass feedstock further complicates HTL operations. Biomass with high moisture content is particularly problematic because the presence of excess water requires more energy for heating and maintaining the necessary high pressures, thus reducing the overall thermal efficiency of the process. Similarly, biomass with high ash content can lead to mechanical and operational issues, such as fouling and corrosion within the reactor, which not only hampers efficiency but also increases maintenance downtime and costs. These characteristics also raise environmental concerns, as the potential contaminants in the bio-oil could pose disposal and pollution problems if not properly managed.

Moreover, the HTL process is somewhat restrictive in terms of the variety of biomass that can be effectively processed. While HTL can theoretically handle a range of biomass types, in practice, its efficiency and effectiveness can vary significantly depending on the physical and chemical properties of the input materials. This limitation affects the versatility and applicability of HTL in different industrial contexts, where the availability of consistent and suitable biomass feedstock might be limited.

2.5 Catalytic Hydrothermal Liquefaction

Catalytic Hydrothermal Liquefaction (CHTL) offers a significant advancement over traditional Hydrothermal Liquefaction (HTL) by incorporating catalysts to enhance the yield and quality of bio-oil. This development not only addresses efficiency issues associated with conventional HTL but also aims to overcome the challenges posed by biomass with high moisture or ash content (Ghadge et al, 2022). The addition of catalysts marks a pivotal shift towards increased operational flexibility and potentially reduces the environmental impacts of the liquefaction process. The choice of catalyst is crucial for the CHTL process. Heterogeneous catalysts are widely used in the process of hydrothermal liquefaction. For example, in the hydrothermal liquefaction of lignocellulosic biomass, researchers have identified four main types of heterogeneous catalysts, each selected for their distinct impacts on the yield and quality of bio-crude. These include catalysts based on alkaline earth metals such as calcium oxide and magnesium-based oxides, which are known for their basic characteristics that help in breaking down carbohydrates. Transition metals like nickel and copper are also used, recognized for their robust catalytic activities that boost liquid yields through various chemical reactions. Additionally, lanthanide oxides, including lanthanum and cerium, are employed for their resistance to coke formation and ability to enhance the quality of bio-crude. Lastly, zeolites, microporous aluminosilicate minerals, are utilized for their acidity and shape selectivity, which are particularly beneficial in the bio-crude upgrading process (Scarsella et al, 2020). These catalysts not only enhance the efficiency and yield of the HTL process but also offer benefits in terms of catalyst recovery and reuse, reducing the overall costs and improving the sustainability of the process.

Catalytic Hydrothermal Liquefaction (CHTL) represents an advancement in the traditional hydrothermal liquefaction (HTL) processes, aiming to improve the conversion of biomass into biocrude by facilitating chemical reactions that standard HTL struggles to achieve efficiently. This is particularly important when dealing with biomass feedstocks that have problematic characteristics such as high moisture or ash content. By incorporating catalysts, CHTL addresses these challenges, enhancing the reactivity and potentially reducing the severity of the operational conditions required.

The transition to CHTL highlights a strategic shift towards enhancing the technology's operational flexibility and reducing its environmental footprint. This includes diminishing the reliance on external chemical inputs and lowering greenhouse gas emissions by optimizing reaction conditions to be less energy-intensive. Furthermore, the incorporation of catalysts in CHTL can lead to higher yields of biocrude with improved quality, which is crucial for its subsequent upgrading into usable fuels.

As research into CHTL progresses, the focus expands to include several critical areas: selecting appropriate catalysts that are not only effective but also economically viable and environmentally benign; fine-tuning the operational parameters such as temperature, pressure, and residence time to maximize efficiency and output; and thoroughly understanding how these factors influence the physicochemical properties of the produced biocrude. This understanding is essential to ensure that the biocrude is suitable for further upgrading processes, such as hydrodeoxygenation, which are necessary to produce high-quality biofuels.

Moreover, ongoing exploration in CHTL aims to develop a deeper understanding of the catalysts' lifecycle, including their stability, reusability, and eventual disposal or regeneration. Addressing these aspects will help in designing a process that not only boosts performance but also aligns with the principles of sustainability and circular economy. This holistic approach to improving CHTL technology will play a pivotal role in its adoption and success as a viable alternative to conventional fossil fuel-based processes.

CHAPTER 3: METHODOLOGY

Overview

The methodology of this study encompasses a thorough literature review, data collection, data categorization and analysis pertaining to Catalytic Hydrothermal Liquefaction. As Figure 7 shows, the initial efforts focused on surveying recent scholarly articles, followed by the creation of a specialized template for data extraction from these sources. With the information categorized, particularly for feedstocks and catalysts, a series of Excel-based analyses, including filtering and chart generation, facilitated the examination of key relationships such as the impact of reaction conditions on biocrude yield. This streamlined method yielded insights into prevalent trends and data reporting habits in the current body of research.

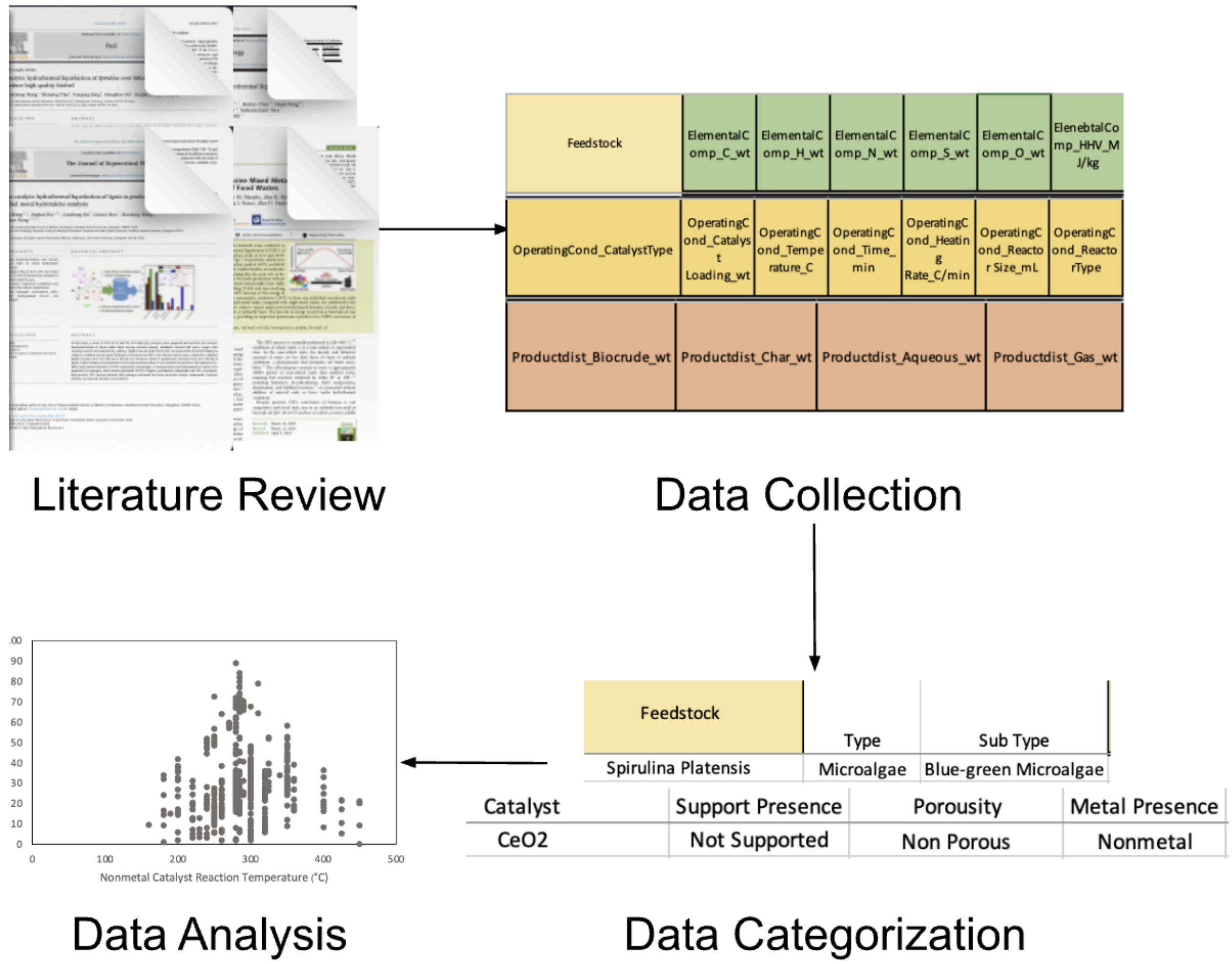

Figure 7: This flowchart illustrates the study's methodology, encompassing literature review, data collection, categorization, and analysis to investigate the impact of reaction conditions on Catalytic Hydrothermal Liquefaction yield.

3.1 Literature Review

This project commenced with a comprehensive literature review, conducted primarily through Google Scholar. The search was strategically focused on scholarly articles published between 2020 and 2022, using the specific keywords "Catalytic Hydrothermal Liquefaction". A total of 57 papers were meticulously examined to ensure a robust analysis of recent advancements in this field.

The primary emphasis of the review was on the experimental methods and the results reported in the papers. Particular attention was paid to data tables, which are crucial as they often contain varying details such as feedstock composition and product yields, essential for understanding the scope and implications of each study.

Upon identifying papers that provided valuable data pertinent to my research objectives, these articles were categorized and stored in a designated data collection folder. This systematic organization facilitated the subsequent data extraction phase.

3.2 Data Extraction

To streamline the data extraction process, a detailed data collection template was developed. This template was designed to capture a comprehensive array of information, including: Feedstock Details: Name, solid loading, and elemental composition (carbon, hydrogen, nitrogen, oxygen, and higher heating value (HHV)); Biochemical Composition: Quantitative analysis of lipid, protein, cellulose, hemicellulose, carbohydrates, lignin, and ash content; Operational Conditions: Type and load of catalyst, temperature, duration, heating rate, reaction scale, and reactor type; Product Distribution: Quantities of biocrude, char, aqueous by-products, and gas produced.

The template, illustrated in Figure 8, ensures a consistent and thorough approach to data collection across all reviewed literature, supporting the reliability and comparability of the extracted data.

Feedstock	Elemental Composition (wt% d.b.)						Biochemical Composition (wt.% d.b.)						
	C	H	N	S	O	HHV (MJ/kg)	Lipid	Protein	Cellulose	Hemicellulose	Carbohydate	Lignin	Ash

	Operating Condition							Product Distribution (wt.% d.b.)			
Solid Loading (g)	Catalyst Type	Catalyst Loading (wt.%)	Temperature (°C)	Time (min)	Heating Rate (°C/min)	Reactor Size (mL)	Reactor Type	Biocrude	Char	Aqueous	Gas

Figure 8: The data collection template visualizes the categories of information captured for Catalytic Hydrothermal Liquefaction research.

Following the literature review, I initiated the data extraction process by methodically populating the previously developed template with data points from all 57 relevant papers as shown in the Appendix, referenced as (Kandasamy et al, 2020; Biswas et al, 2020; Durak & Genel, 2020; Cheng et al, 2020; Wang et al, 2020; Kaur et al, 2020; Lu et al, 2020; Arun et al, 2020; Ma et al, 2020; Durak, 2019; Xu et al, 2020; de Caprariis et al, 2019; de Caprariis et al, 2020; Li et al, 2020; Cao et al, 2021; Biswas et al, 2021; Liu et al, 2021; Prestigiacomo et al, 2021; Lu et al, 2021; Feng et al, 2021; Seehar et al, 2021; Taghipour et al, 2021; Jia et al, 2021; Li et al, 2021; Alvarez et al, 2020; Hong (1) et al, 2021; Dang et al, 2021; Motavaf et al, 2021; Wang et al, 2021; Kandasamy et al, 2021; Zhao et al, 2021; Rahman et al, 2021; Chukaew et al, 2021; Hong (2) et al, 2021; Nonchana et al, 2017; Alper et al, 2021; Ma et al, 2021; Chen et al, 2021; Yang et al, 2021; Zhang et al, 2022; Haque et al, 2022; Wang G et al, 2022; Malpica-Maldonado et al, 2022; Mustapha et al, 2022; Goswami et al, 2022; Wang Y et al, 2022; Nurul Surriana et al, 2022; Zhu et al, 2022; Kopperi et al, 2022; Lu et al; 2022, Ding et al, 2022; Wang C et al, 2022; Liu M et al, 2022; Jazie et al, 2022; Zhou et al, 2022; Liu Q et al, 2022; Wu et al, 2022). Given the variability in reporting standards across different studies, not all papers included complete data for every parameter specified in the template. Where data were unavailable or not reported, I marked these instances as 'N/R' (Not Reported) to maintain clarity and consistency in data tracking.

Upon completing the data collection from the designated papers, I proceeded to the analysis phase. The initial step in this phase involved assessing the completeness of the data. This was accomplished by calculating the percentage of reported data points for each category within the template. This analysis helped identify which categories frequently lacked data and which were most consistently reported, providing insights into the dataset's overall integrity and the research community's reporting tendencies.

For practical handling and analysis of the dataset, I employed Microsoft Excel. Utilizing Excel's Filter feature enabled me to segregate and exclude the 'N/R' entries effectively, facilitating an accurate assessment of reported data across different categories. This preliminary filtering process was visualized in a schematic representation Figure 9.

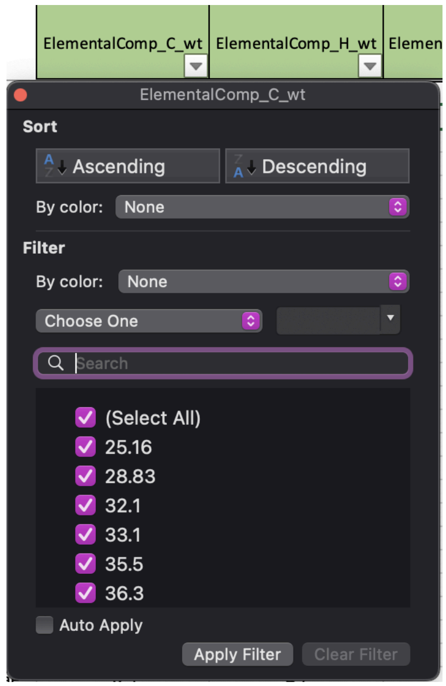

Figure 9: Excel's filter function in action, demonstrating the selection of reported carbon weight percentages from the database.

Subsequently, I generated a bar chart to visually represent the data completeness. The chart's vertical axis displayed the percentage of data reporting, while the horizontal axis categorized the different data types included in the study. This graphical representation served as a critical tool for visualizing patterns and gaps in the data reported across the studies.

3.3 Data Categorization

The subsequent phase of the analysis involved a detailed categorization of the feedstocks and catalysts used in the studies. For feedstocks, I organized them into two hierarchical levels: type and subtype. There are six main types of feedstock: biomass, macroalgae, microalgae, model compounds, waste, and woody biomass.

Each main category was further divided into subtypes to provide a nuanced classification. For example, biomass includes agricultural biomass and other lignocellulosic biomasses; woody biomass is divided into hardwood and softwood; macroalgae is classified into brown, green, and red macroalgae; microalgae includes blue-green and green microalgae; model compounds are categorized into polysaccharides; and waste covers complex waste, food waste, and industrial waste. Illustrative examples include cow manure, which is classified under agricultural waste—a subtype of waste; Spirulina platensis categorized as blue-green microalgae; and oak wood, which falls under the subtype of hardwood in woody biomass.

Using these classifications, all feedstock data points were systematically organized. I utilized the Excel Filter feature to accurately quantify the data entries in each category as shown in Figure 10. This enabled the creation of bar charts and pie charts to depict the number of samples reported for each category and the percentage distribution of each category among all types and subtypes, providing a clear and comprehensive visualization of the data landscape.

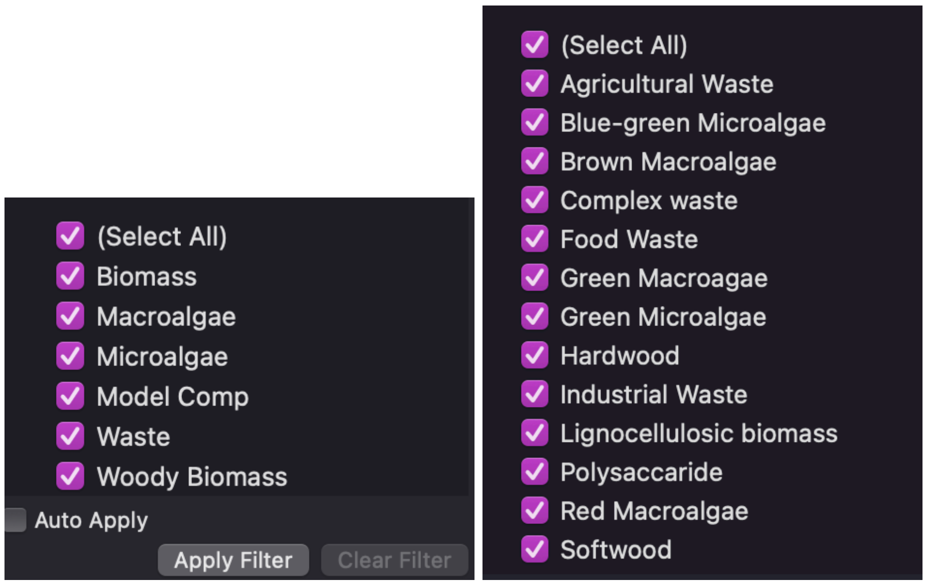

Figure 10: Excel's Filter function showcasing the classification and selection of feedstock types and subtypes for accurate data quantification and subsequent visualization in analytical charts.

Subsequent to the feedstock categorization, the catalysts utilized in the studies were systematically classified into three distinct categories to facilitate a comprehensive analysis. The first category assesses the support structure of the catalyst, distinguishing between supported catalysts, non-supported catalysts, and other types. The second category evaluates the porosity, specifically identifying whether the catalyst is porous or non-porous. The third and final category determines the presence of metals, classifying the catalysts into those containing metals and those that do not. An illustrative example of this categorization is depicted in Figure 11.

Given the diversity of catalysts encountered in the literature and to ensure a thorough understanding of those that were unfamiliar, extensive online research was conducted. This research involved consulting reputable scientific resources such as the American Chemical Society (*ACS*), Science Direct (*Science Direct)*, and the Multidisciplinary Digital Publishing Institute (*MDPI*).

Frequently, the properties of a catalyst, such as the presence of metals like Iron or Zinc, can be readily inferred from basic chemistry knowledge. For example, the inclusion of a metal in the chemical formula of a catalyst typically indicates its presence. This foundational understanding was pivotal in accurately categorizing each catalyst based on its chemical composition and physical properties.

Catalyst	Support Presence	Porousity	Metal Presence
CeO2	Not Supported	Non Porous	Nonmetal

Figure 11: Categorization of the CeO2 catalyst as not supported, non-porous, and nonmetal, exemplifying the systematic classification method for catalyst analysis.

3.4 Data Analysis

With the data collection process complete and categorizations of both feedstock and catalysts finalized, the analysis phase focused on the relationship between reaction conditions and biocrude yield. Initially, I utilized the Excel filter feature to segregate the data by feedstock category, extracting specific information on reaction time, reaction temperature, and biocrude yields for each type.

For all the data I collected, I conducted a detailed analysis to assess how the reaction temperature and time influenced the biocrude yield. This involved generating scatter plots for all the data points, with the vertical axis representing the biocrude yield and the horizontal axis alternating between reaction temperature and reaction time. These plots facilitated a visual representation of the correlations between the reaction conditions and the yields.

Following a similar methodology, I extended the analysis to the catalysts. Given the three distinct categories identified in the catalyst classification, I produced scatter plots for each, illustrating the relationship between biocrude yield and both reaction time and temperature. This comparative analysis across different catalyst types enabled a nuanced understanding of how catalyst characteristics influence the efficiency of the biocrude production process.

This analytical approach not only highlighted specific trends and outliers but also supported a more comprehensive interpretation of how different reaction parameters affect biocrude yield across varied feedstocks and catalysts.

CHAPTER 4: RESULTS & ANALYSIS

Overview

This section provides the findings and analyses from extensive catalytic hydrothermal liquefaction research. Data across studies reveal a nuanced understanding of feedstock characteristics and catalyst efficiency. The reporting frequency analysis indicates a strong focus on elemental composition and biocrude yield, highlighting key priorities in feedstock characterization and output evaluation. A diversity of feedstocks - from various biomasses to complex wastes - is actively explored, underscoring a commitment to sustainability and energy recovery. Catalysts are meticulously categorized, with supported and porous varieties preferred for their potential to enhance reaction efficiency. Reaction parameters are closely scrutinized, with temperature and time identified as critical factors influencing biocrude yield, revealing specific ranges that optimize production. The findings collectively underscore strategic research directions, pinpointing the drive for efficiency, thorough material characterization, and the valorization of renewable resources in catalytic hydrothermal liquefaction processes.

4.1 Percentage of Reported Parameters Analysis

Figure 12 provides a color-coded visual breakdown of the culinary feedstock input, operating parameters, and outputs in catalytic hydrothermal liquefaction studies. The elemental composition of carbon, hydrogen, nitrogen, sulfur, and oxygen, crucial for characterizing feedstocks, is prominently reported, as shown by the orange bars around 80% reporting frequency. In comparison, the Higher Heating Value (HHV) is marked in yellow and, while significant, it is documented slightly less consistently. The chart further reveals, with purple bars, the moderate to sporadic reporting of biochemical composition parameters, such as lipids and proteins, suggesting a variable emphasis on these measures. Feedstock ash content is notably as well-documented as the elemental composition, underscoring its importance in characterizing feedstocks. The biocrude yield, a pivotal focus in the literature, is distinguished by a red bar with reporting rates closely to 100%. By-products like the aqueous phase and gas, however, depicted in blue and green, show low reporting frequency, indicating potential challenges in measurement or varying relevance to research aims. Collectively, the chart delineates a reporting hierarchy within feedstock parameters, illuminating the most and least emphasized factors in the research field, and pointing to potential areas for standardization and focused investigation.

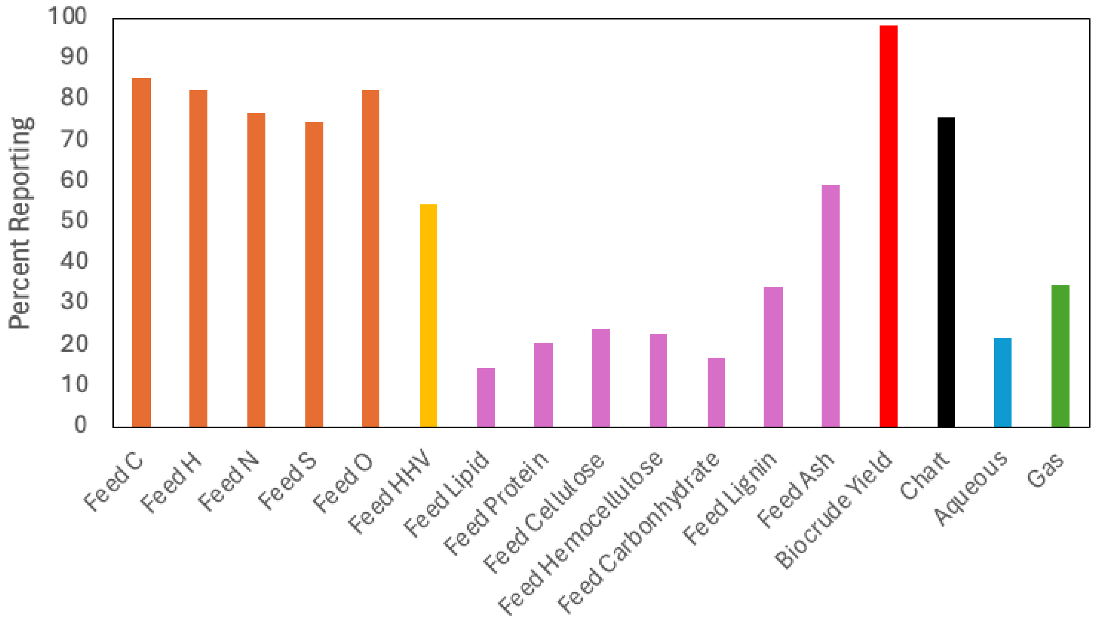

Figure 12: The bar chart depicts the percentage reporting of various feedstock parameters in the literature.

4.2 Feedstock Categorization Analysis

The pie chart shown in Figure 13 represents the distribution of feedstock types in catalytic hydrothermal liquefaction research, with Other Biomass leading at 26%, indicative of the broad interest in various biomass sources. Close behind, Waste constitutes 21% of the feedstock distribution, underscoring the research focus on converting waste to energy. Microalgae, with a 19% share, reflects its rising prominence due to its renewable energy potential, while Macroalgae at 12% and Woody

Biomass at 16% highlight the interest in both aquatic and terrestrial plant sources. The smallest slice is Model Compound at 6%, pointing to its specialized use for simulating specific feedstock components or reactions. Collectively, the chart showcases a diversified research landscape, with a clear preference for biomass and waste, suggesting a strategic emphasis on sustainability and the valorization of various organic materials for fuel production.

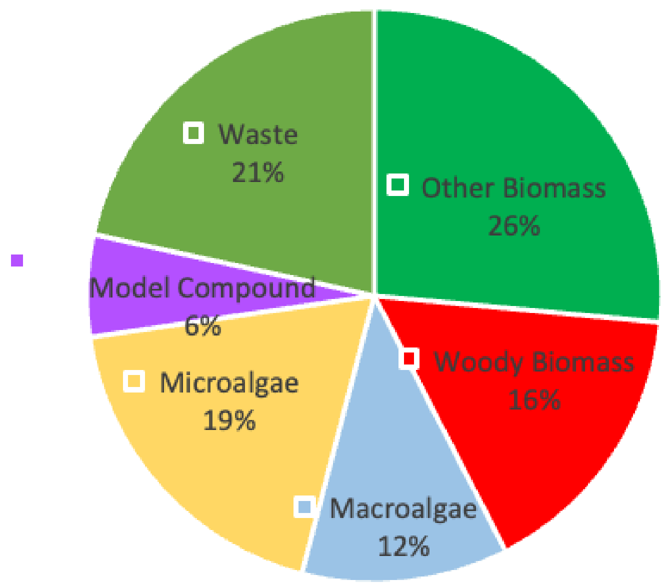

Figure 13: Distribution of feedstock types utilized in catalytic hydrothermal liquefaction research, highlighting the prevalence of various biomass, waste, and model compounds.

Following the categorization of feedstock types into specific subtypes, Figure 14 provides an intricate breakdown of the feedstock subtypes employed in catalytic hydrothermal liquefaction research, showcasing the depth and precision of materials being investigated. Dominating the chart, Other Lignocellulosic Biomass accounts for 28% of the feedstock subtypes, suggesting a broad interest in this diverse group of plant-based materials. The significant 12% portion occupied by Green Microalgae highlights the burgeoning focus on this group for its promising biofuel production capabilities. Combined, Soft Wood and Hard Wood make up 15%, pointing to the considerable utilization of forestry products within the field. Waste materials, categorized as Complex Waste, Food Waste, and Industrial Waste, collectively comprise 19%, demonstrating the sector's commitment to waste valorization. At 6%, model compounds like Polysaccharide indicate targeted research into the core chemical processes of hydrothermal conversion. The smaller slices representing various algae suggest a rich interest in aquatic biomasses, with Agricultural Biomass receiving the least focus. This detailed categorization underlines the comprehensive and varied approach of the research community in exploring a spectrum of feedstocks, ranging from robust plant matter to specific waste types and aquatic organisms.

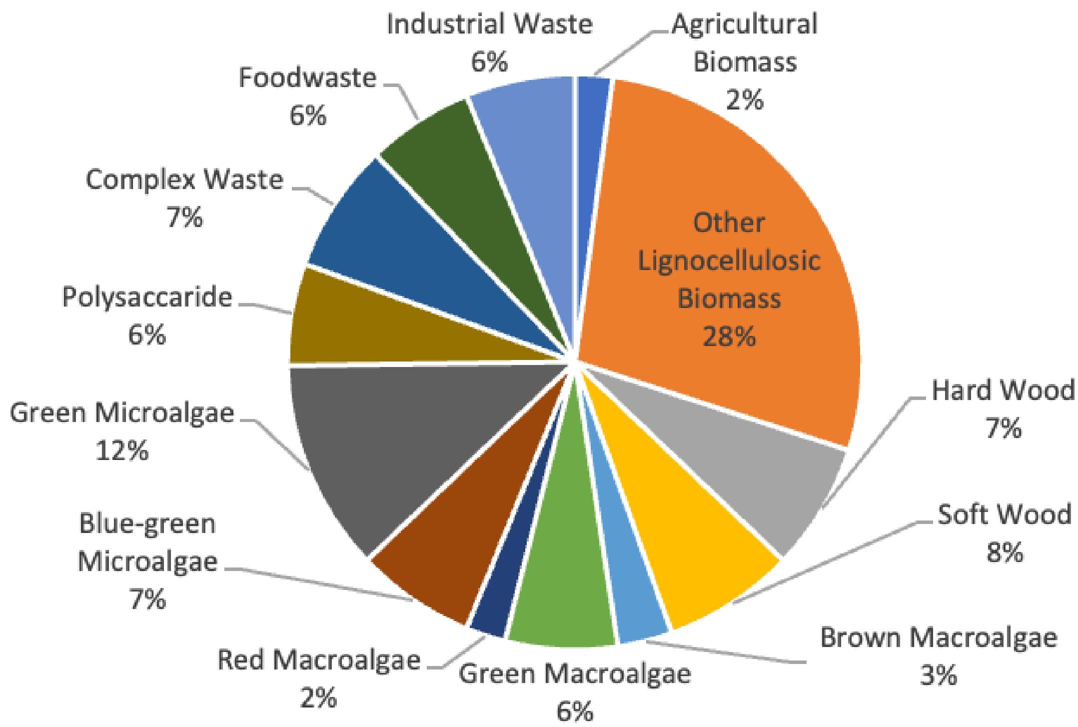

Figure 14: Subtype Distribution of Feedstocks in Catalytic Hydrothermal Liquefaction Research Highlighting Material Diversity and Research Focus Areas.

The bar chart in Figure 15 provides a clear depiction of the diversity and frequency of feedstock subtypes used in catalytic hydrothermal liquefaction research. It shows that Other Lignocellulosic Biomass is the predominant subtype with 199 samples, which suggests that it is a focal point of research, likely because of its abundant availability and suitability for biofuel production. This subtype alone accounts for roughly 28% of the total 714 samples represented in the study, underscoring its significance.

Woody Biomass is represented by Hard Wood and Soft Wood, with 51 and 53 samples respectively, indicating a balanced interest in these subtypes, potentially due to their differing physical and chemical properties that may affect the liquefaction process.

In the algae categories, Green Microalgae takes a leading position with 85 samples, followed by Blue-green Microalgae with 48 samples. This reflects a significant interest in microalgae, likely due to their rapid growth rates and high lipid content which are advantageous for biofuel production. Among the macroalgae, Green Macroalgae is the most studied subtype with 45 samples, more than double Brown Macroalgae at 22 samples and nearly three times Red Macroalgae at 16 samples, indicating specific research interests possibly tied to their different biochemical compositions and yields.

The model compound Polysaccharide is represented with a substantial 41 samples, underlining its importance in researching the fundamental aspects of the hydrothermal conversion process and the chemical interactions involved.

The Waste category displays a relatively even distribution among Complex Waste (52 samples), Food Waste (43 samples), and Industrial Waste (44 samples), suggesting that waste materials are being actively investigated as a resource for biofuel production, reflecting the sector's interest in sustainable waste management and valorization strategies.

Finally, Agricultural Biomass has the least representation with 15 samples, which might indicate that while it is of interest, it is less prioritized compared to other biomass types or that it is often included in the broader category of Other Lignocellulosic Biomass.

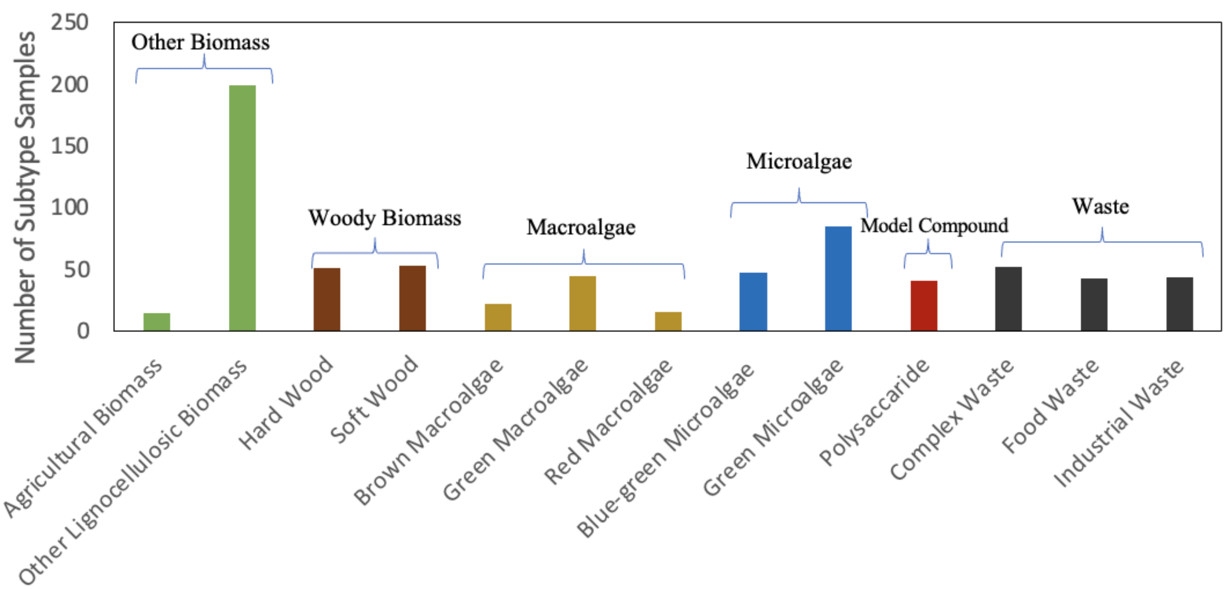

Figure 15: Quantitative Analysis of Feedstock Subtypes in Catalytic Hydrothermal Liquefaction Research, Indicating Research Preferences and Trends

4.3 Catalysts Categorization Analysis

Figure 16 depicts the classification of catalysts used in the catalytic hydrothermal liquefaction process into three categories: supported catalysts, non-supported catalysts, and other catalysts With 325 samples, supported catalysts are the most frequently used, suggesting that catalysts with a support material are preferred in this field, potentially for their increased surface area, stability, or ability to improve the dispersion of active sites.

Non-supported catalysts are also widely used, with 287 samples, indicating a significant body of research focusing on catalysts that do not require a support matrix. This could suggest that, for certain applications, the intrinsic activity of the catalyst without support is sufficient, or that unsupported catalysts are chosen for their simplicity, cost-effectiveness, or specific catalytic properties.

The Other Catalysis category, which includes 102 samples, represents a diverse group of materials such as fly ash, various forms of calcium hydroxide (Ca(OH)2), boric acid (H3BO3), metal chlorides like copper chloride (CuCl2) and iron chloride (FeCl3), as well as biochars and zeolites. These are likely used in research for their unique properties that could contribute to the liquefaction process in different ways, such as acidity or basicity, porosity, or thermal stability.

The inclusion of materials like montmorillonite, a type of clay, and various biochars indicates an interest in testing natural and modified substances, perhaps for their porosity and adsorption properties. The presence of chemical compounds such as formic acid (HCOOH), acetic acid (CH3COOH), and sodium hydroxide (NaOH) suggest research into the catalytic effects of pH modification.

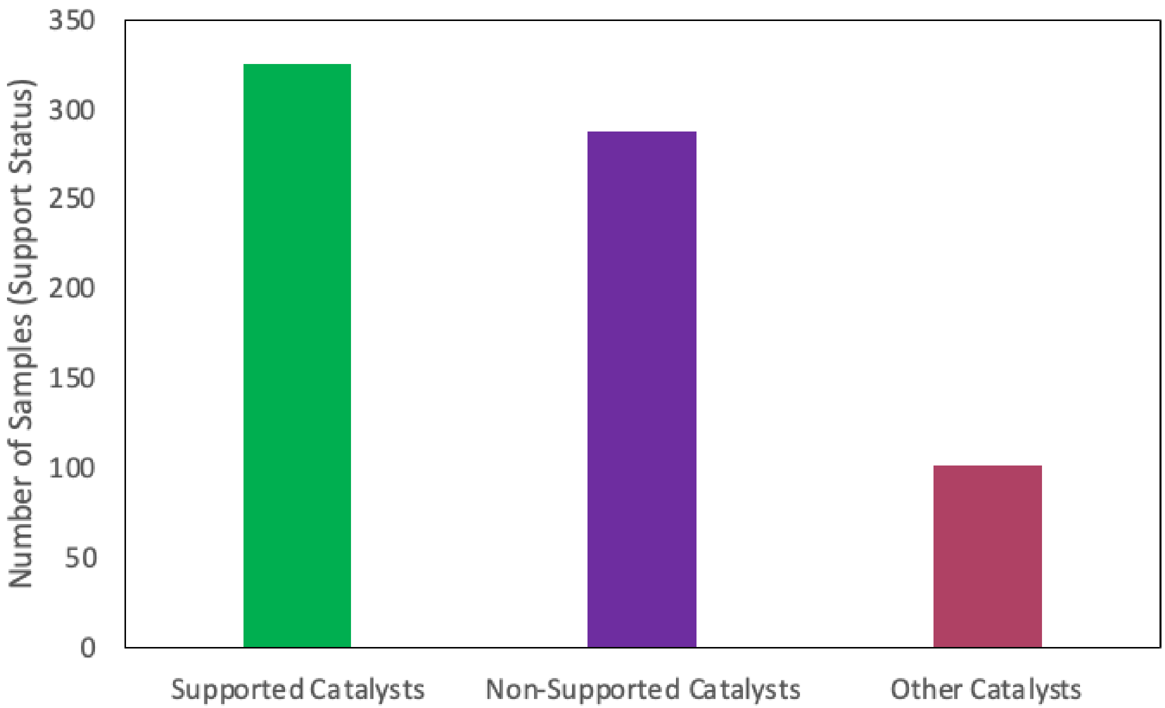

Figure 16: Categorization of Catalysts Used in Catalytic Hydrothermal Liquefaction Studies, Highlighting the Prevalence of Supported and Not Supported Types.

The bar chart, Figure 17, presents the use of catalysts classified by porosity in catalytic hydrothermal liquefaction studies. Porous catalysts, with 408 samples, are the most commonly used according to the chart, indicating a strong preference in research for catalysts with porous structures. This preference could be due to the large surface area provided by porous materials, which can potentially increase reaction rates and catalytic efficiency.

Non-porous catalysts are also significantly represented with 302 samples. Their use suggests that for certain reactions or under certain conditions, the properties of non-porous catalysts are favorable or sufficient, despite their typically smaller surface area compared to porous materials.

A negligible number of samples, only 4, are marked as NR (Not Reported), which indicates that nearly all studies clearly specify the porosity of their catalysts. This high level of reporting suggests that porosity is considered a critical characteristic for catalysts in hydrothermal liquefaction processes.

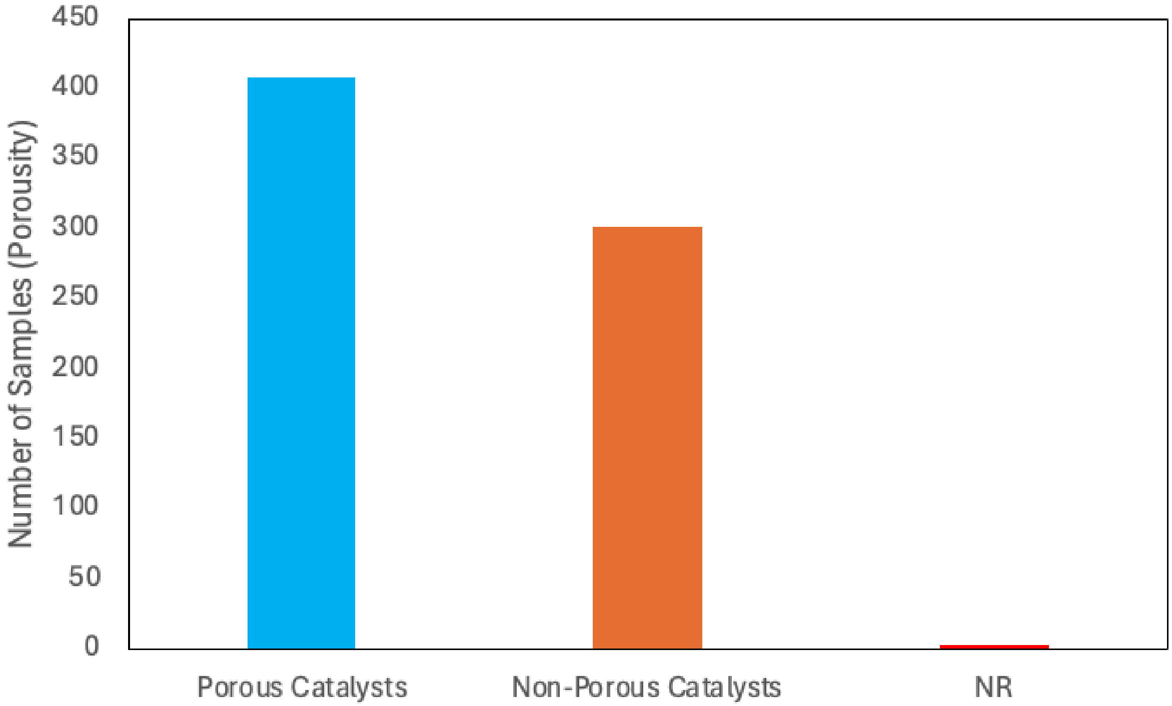

Figure 17: Prevalence of Porous and Non-Porous Catalysts in Catalytic Hydrothermal Liquefaction Research.

The bar chart as shown in Figure 18 presents a comparative analysis of catalyst samples categorized by the presence of metals in the catalytic hydrothermal liquefaction process. The Metal Catalysts category, represented by a yellow bar, comprises 138 samples, significantly lower than its counterpart. In contrast, the Non-Metal category, shown by a gray bar, encompasses a substantially larger set of 576 samples. This stark contrast indicates a predominant utilization or efficacy of non-metal catalysts in this specific process. The chart effectively conveys this disparity, although a title and numerical labels could enhance its explanatory power. It is noteworthy that the substantial difference in sample size may suggest underlying trends in catalyst selection, operational costs, availability, or performance between metal and non-metal catalysts in hydrothermal liquefaction.

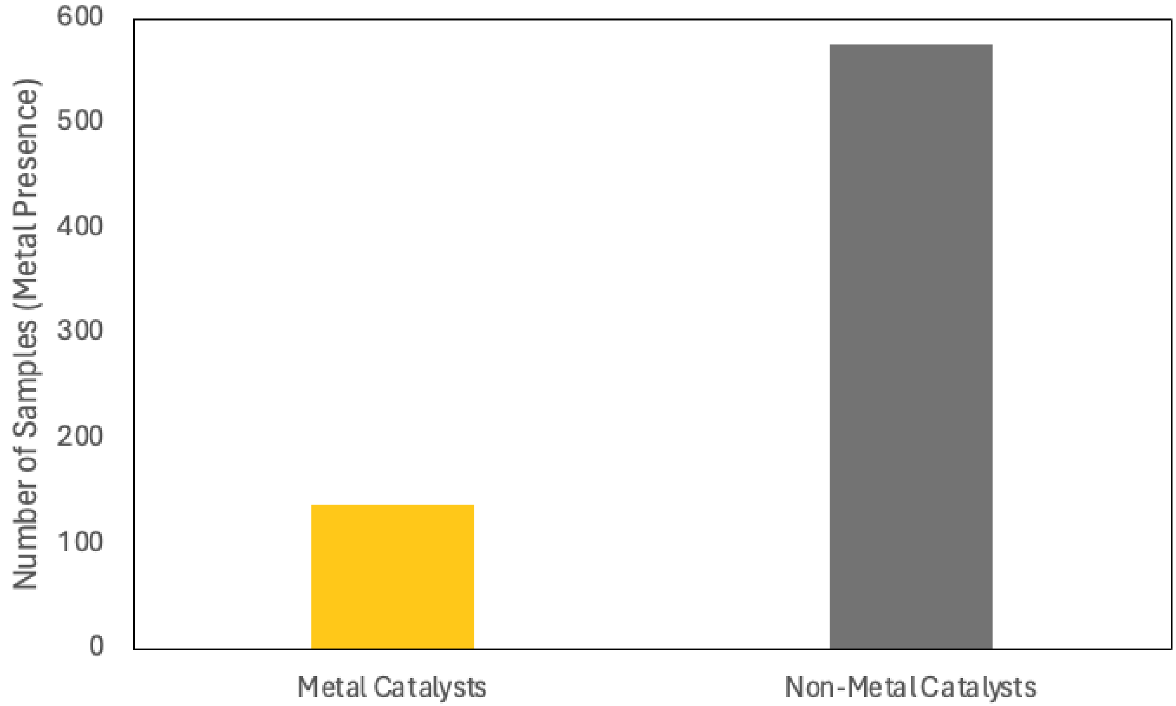

Figure 18: Comparison of Metal vs. Non-Metal Catalyst Samples in Hydrothermal Liquefaction.

4.4 Reaction Time Vs. Biocrude Yield Analysis

Figure 19 presents a scatter plot that captures the complex relationship between reaction time and biocrude yield from a range of catalytic hydrothermal liquefaction processes across various feedstocks, based on a comprehensive dataset of 714 data points. The plot reveals a concentration of experiments with reaction times up to 60 minutes, underscoring a preference in the field for shorter-duration reactions - likely motivated by considerations of energy efficiency and cost.

In particular, the plot shows that reaction times yielding high biocrude production, above 70%, are predominantly within a span of 15 to 60 minutes. This observation suggests that there may be a sweet spot in terms of reaction time for optimizing yield. However, given the dispersion of data across the reaction time spectrum, it's evident that achieving optimal biocrude production involves a multifaceted interplay of conditions.

The variability is further highlighted by the presence of outliers, especially noticeable at extended reaction times where the yield results are less consistent. These outliers may point to threshold limits or diminishing returns in yield efficiency as reaction times increase.

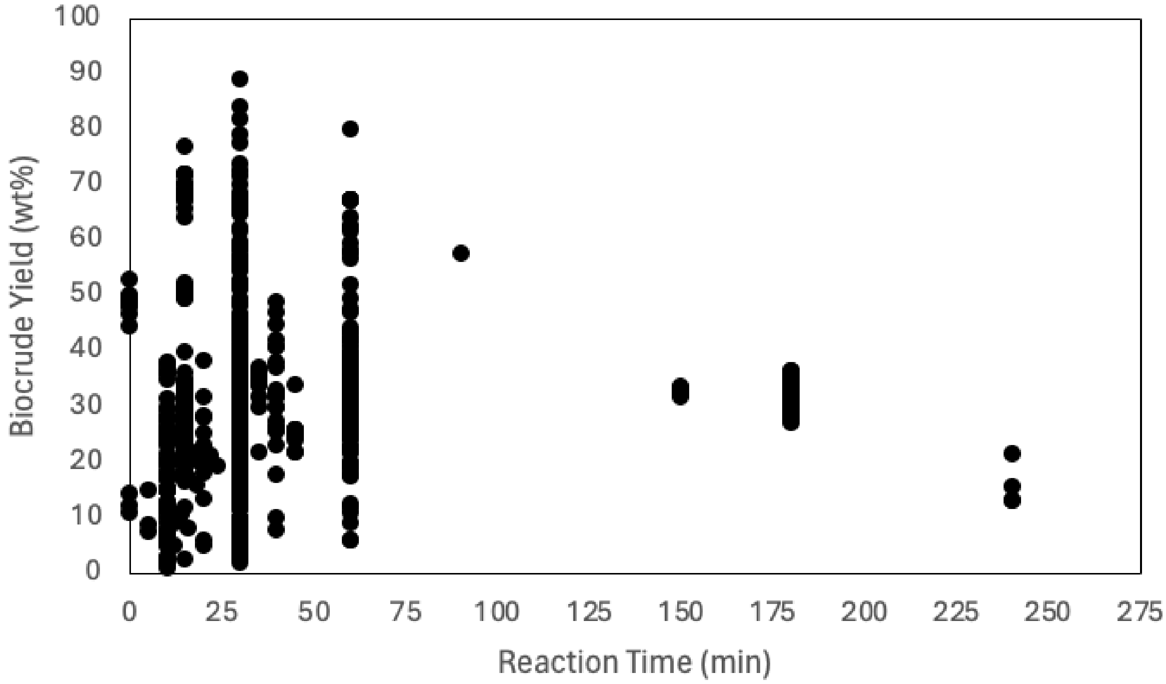

Figure 19: Biocrude Yield Versus Reaction Time from 714 data points of Catalytic Hydrothermal Liquefaction Experiments.

Figures 20-a and 20-b provide comparative visualizations of biocrude yields against reaction times for supported and unsupported catalysts, respectively, in catalytic hydrothermal liquefaction processes. In Figure X-a, there is a conspicuous cluster of higher yields, with 45 data points showing yields greater than 60% out of a total of 328 experiments using supported catalysts. This suggests a relatively high frequency of efficient biocrude production when supported catalysts are utilized. The reaction times associated with these high yields range from 15 to 60 minutes, implying that the presence of a supported catalyst can enhance biocrude yield within this timeframe.

In contrast, Figure X-b, representing unsupported catalysts, shows just one instance out of 287 where the biocrude yield exceeded 60%. This stark difference suggests that supported catalysts significantly outperform unsupported ones in achieving high yields of biocrude. The reaction times in Figure X-b are also spread out over a broader range, but without the high yield peaks observed in Figure X-a, which could indicate that the supported catalysts plays a pivotal role in the efficiency of the catalytic hydrothermal liquefaction process.

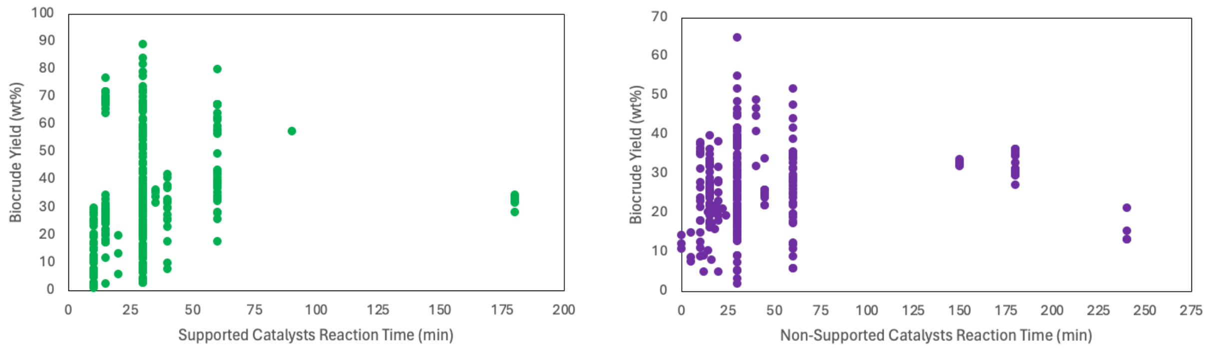

Figure 20-a & 20-b: Biocrude Yield Versus Reaction Time with Supported Catalysts & Non-Supported Catalysts in Catalytic Hydrothermal Liquefaction.

Figure 21-a displays the biocrude yield using porous catalysts in the catalytic hydrothermal liquefaction process, with a notable maximum yield of approximately 89%. Out of 408 experiments using porous catalysts, there are 47 instances (approximately 11.5% of the cases) where the yield exceeded 60%, underscoring the potential high efficiency of porous catalysts in generating biocrude. The data indicates that the most productive reaction times range from 15 to 50 minutes. However, the efficiency visibly declines after 100 minutes, as seen by the decrease in both the number of data points and the biocrude yield percentages.

In marked contrast, Figure 21-b, detailing the use of non-porous catalysts, shows a substantially lower maximum yield of 65%, with just one instance out of 302 experiments (around 0.3%) achieving over 60% yield. This graph indicates a broader distribution of reaction times, extending up to 240 minutes, but lacks the concentrated efficiency observed with porous catalysts. The general trend points to a lower and more inconsistent yield, highlighting the relative inefficiency of non-porous catalysts in the process. The sparse high-yield occurrences and the lower peak yield strongly suggest that non-porous catalysts fall short in comparison to porous ones for biocrude production in the catalytic hydrothermal liquefaction process.

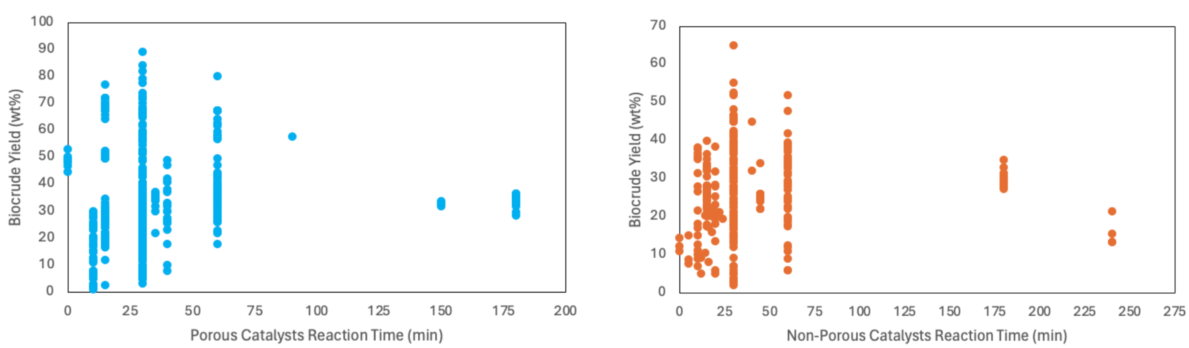

Figure 21-a & 21-b: Biocrude Yield Versus Reaction Time with Porous Catalysts & Non-Porous Catalysts in Catalytic Hydrothermal Liquefaction.

For the metal catalysts (Figure 22-a), the data exhibits a peak biocrude yield of 72%. Analyzing the 138 experimental data points, it is observed that only 7 experiments (approximately 5.1%) achieve a yield above 60%, indicating a relatively lower frequency of high-yield outcomes compared to non-metal catalysts. The graph illustrates that the highest biocrude yields for metal catalysts predominantly occur within a narrow time frame, specifically between 15 to 30 minutes of reaction time. Beyond this interval, the yield appears to decline, suggesting a sharp optimum time frame for achieving high yields with metal catalysts.

In contrast, the non-metal catalysts (Figure 22-b) achieve a higher peak yield of 89%, reflecting a more substantial biocrude production capacity. Among the 567 experiments using non-metal catalysts, 41 data points (around 7.2%) surpass the 60% yield threshold, denoting a greater incidence of high-yield results in comparison to metal catalysts. The distribution of higher yields is also more spread out across reaction times, with the most effective reaction period ranging from 15 to 60 minutes. This broader time frame suggests that non-metal catalysts not only facilitate higher yields but also maintain these yields over a wider range of reaction times.

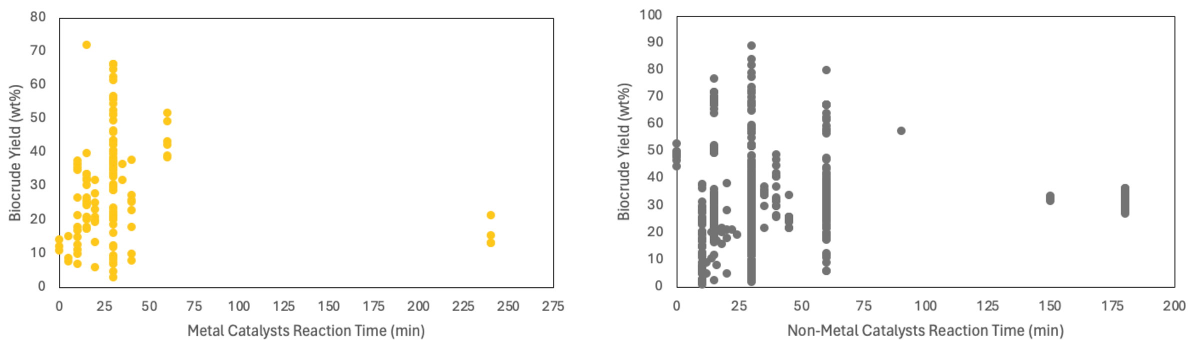

Figure 22-a & 22-b: Biocrude Yield Versus Reaction Time with Metal Catalysts & Non-Metal Catalysts in Catalytic Hydrothermal Liquefaction.

4.5 Reaction Temperature Vs. Biocrude Yield Analysis

Figure 23 presents an analysis of biocrude yield versus reaction temperature from a dataset of 714 experiments sourced from catalytic hydrothermal liquefaction research papers.

From the scatter plot, it can be discerned that the reaction temperature varies widely, from 160°C to nearly 450°C. The biocrude yield, depicted on the y-axis, ranges from 1% to nearly 89%. The density of data points suggests that a significant number of experiments were conducted across a broad spectrum of temperatures.

A closer look at the data points reveals that the biocrude yield does not increase linearly with temperature. Instead, there appears to be a zone of temperatures where the yield is higher on average. This zone is between 280°C to 300°C, where we observe a clustering of data points at higher yield percentages. This suggests that the catalytic process tends to be more efficient or effective within this temperature range, as it corresponds with a higher likelihood of obtaining a greater biocrude yield.

Outside of the 280°C to 300°C range, yields are generally lower and more scattered. This indicates that reaction temperatures below 280°C and above 300°C are less favorable for biocrude production in the context of the data presented. However, there are still some instances of high yields at temperatures outside of this optimal range, although they are less frequent.

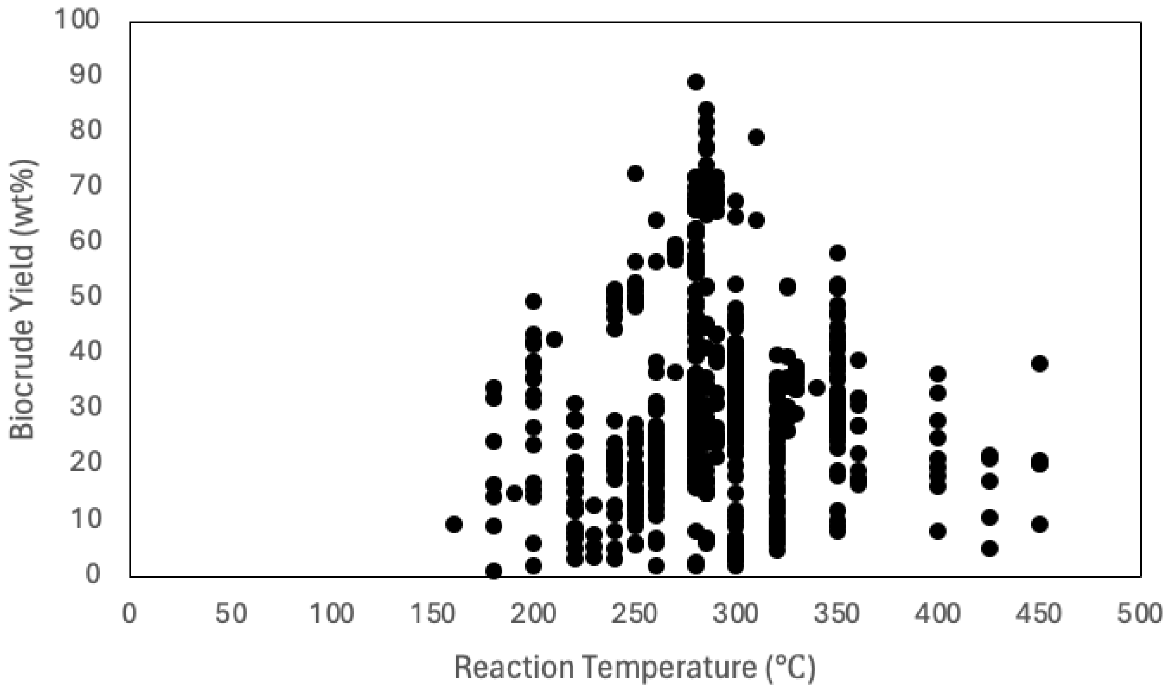

Figure 23: Biocrude Yield Versus Reaction Temperature from 714 data points of Catalytic Hydrothermal Liquefaction Experiments.

In Figure 24-a, depicting supported catalysts, the data suggests an optimal reaction temperature range between 280°C and 310°C. It is within this temperature bracket that the maximum biocrude yield of 89% is achieved. The clustering of data points in this range indicates a strong correlation between reaction temperature and biocrude yield, with the density of higher-yield results being noticeably concentrated around the 280°C to 310°C window. This suggests that supported catalysts function most effectively within this temperature range, likely due to the enhanced activity or stability of the catalyst under these conditions.

Figure 24-b, focusing on non-supported catalysts, shows a slightly different pattern with an optimal reaction temperature range around 280°C to 285°C. While the range is narrower compared to supported catalysts, it is within this range that the non-supported catalysts appear to perform best. However, the maximum yield observed is lower than that of the supported catalysts, indicating that while non-supported catalysts have a specific optimal temperature range, they may not facilitate biocrude production as efficiently overall.

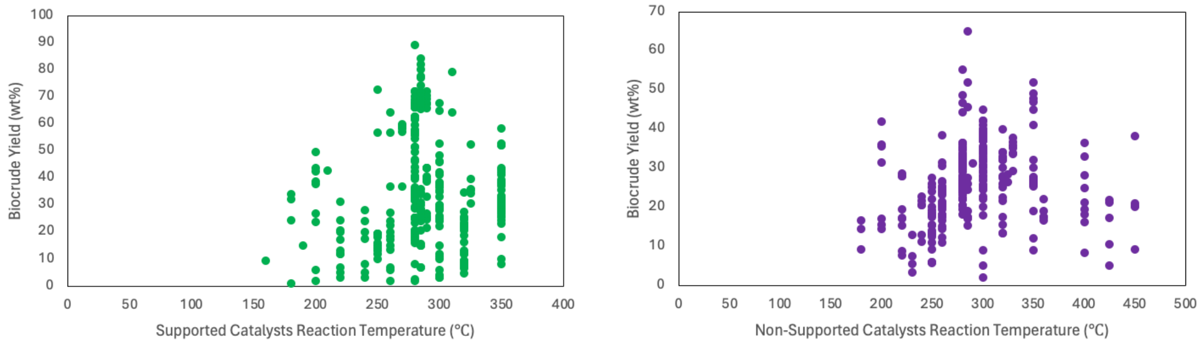

Figure 24-a & 24-b: Biocrude Yield Versus Reaction Temperature with Supported Catalysts & Non-Supported Catalysts in Catalytic Hydrothermal Liquefaction.

Figure 25-a for porous catalysts illustrates a concentration of data points indicating that the optimum temperature range for achieving high biocrude yield is between 280°C to 290°C. Within this temperature window, the yields are higher, suggesting that the porous structure of the catalysts might be contributing to a more effective catalytic reaction. The dense clustering of data points in this range could indicate that the porous catalysts maintain their activity or perhaps prevent the deactivation of the catalytic sites at these temperatures. The spread of the data points throughout the temperature range also suggests variability in the process outcome, potentially due to the nature of the feedstock, the catalyst pore structure, or other process conditions.

For the non-porous catalysts in Figure 25-b, the minimum biocrude yield is about 2% and the graph shows that yields are generally lower compared to those with porous catalysts. The data points are scattered across a broad range of temperatures between 180°C to 450°C, which may suggest that non-porous catalysts have a less defined optimal temperature range and potentially a lower overall catalytic efficiency.

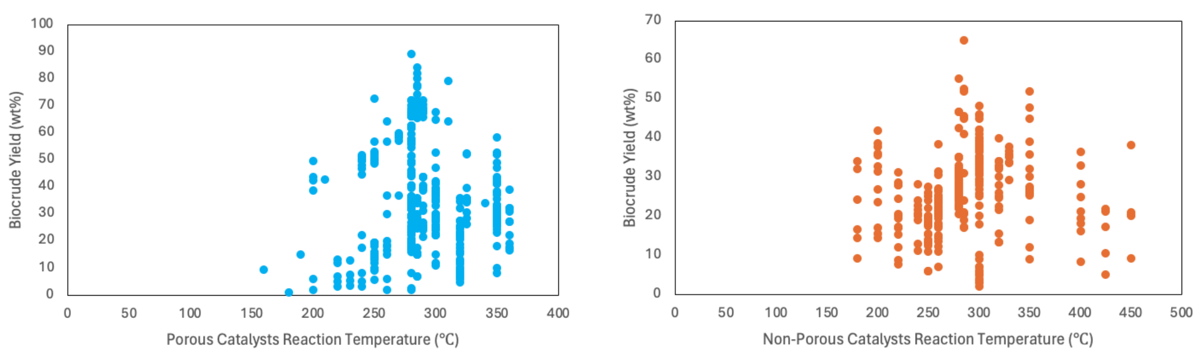

Figure 25-a & 25-b: Biocrude Yield Versus Reaction Temperature with Porous Catalysts & Non-Porous Catalysts in Catalytic Hydrothermal Liquefaction.

Figure 26-a for metal catalysts reveals that the most substantial yields are clustered within the temperature range of 280°C to 300°C, with the highest yield peaking at 72%. This peak at around 290°C indicates a precise optimal temperature window for metal catalysts. The performance drops off

noticeably outside this temperature bracket, emphasizing a sensitive dependence on the reaction temperature for optimal metal-catalyst activity.

Figure 26-b portrays the outcomes for non-metal catalysts, showing a broader temperature range from 280°C to 310°C that facilitates higher biocrude yields. It is within this range that the non-metal catalysts surpass the metal counterparts, achieving a peak yield of up to 89%. The broader effective temperature range suggests non-metal catalysts might be more versatile under varying thermal conditions and still produce high biocrude yields. This characteristic could be particularly beneficial in large-scale operations where maintaining a strict temperature range can be challenging, thus offering some operational leeway without significant drops in yield.

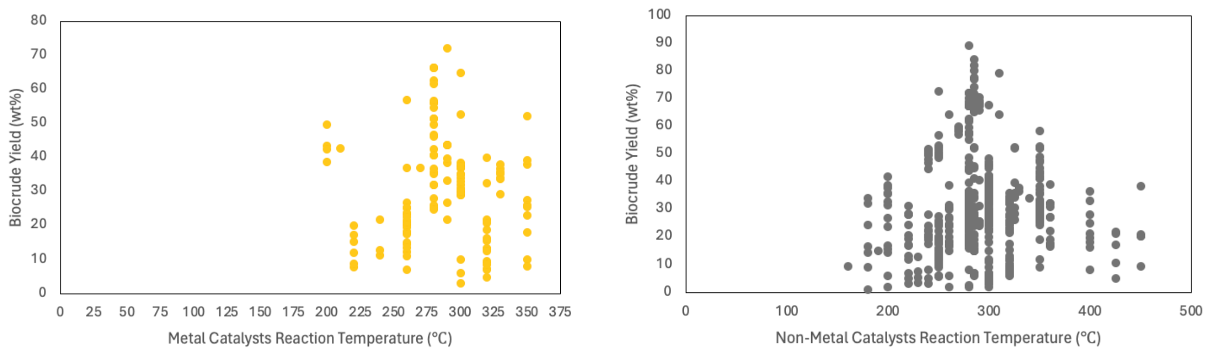

Figure 26-a & 26-b: Biocrude Yield Versus Reaction Temperature with Metal Catalysts & Non-Metal Catalysts in Catalytic Hydrothermal Liquefaction.

4.6 Insights & Advances

This chapter provides a comprehensive overview and detailed examination of the findings from extensive research into CHTL and it synthesizes data from various studies, offering a nuanced understanding of how feedstock characteristics and catalyst efficiency interplay to optimize the HTL process. The elemental composition, biocrude yield, and a diverse array of feedstocks ranging from assorted biomasses to complex wastes are thoroughly investigated. This reflects a committed approach towards sustainable energy recovery and the efficient utilization of resources.

The findings underscore a strategic orientation towards maximizing efficiency, conducting thorough material characterization, and valorizing renewable resources within CHTL processes. The emphasis on elemental composition and biocrude yield as primary research priorities is evident from the high reporting frequency of these parameters. This not only helps in optimizing the process but also in ensuring the quality and usability of the biocrude for further upgrading processes. On the other hand, the lower reporting frequency of by-products like the aqueous phase and gas highlights potential areas for further research, possibly indicating varying relevance to primary research goals. The diversity of feedstocks, particularly the inclusion of various types of biomass and waste, underscores a broad and inclusive approach to sourcing raw materials, aligning with global sustainability goals.

Supported and porous catalysts emerge as favorites due to their potential to improve reaction efficiency. This preference is underpinned by a close scrutiny of reaction parameters, with temperature and time highlighted as critical for influencing biocrude yield. The analysis indicates specific ranges that optimize production, providing actionable insights for future research and operational adjustments.

CHAPTER 5: CONCLUSIONS

This study has provided a comprehensive exploration of Catalytic Hydrothermal Liquefaction (CHTL), focusing on the interplay between feedstock characteristics, catalyst efficiency, and the resulting biocrude yield. Key findings highlight the diverse array of biomass and waste materials utilized as feedstocks, reflecting a strong commitment to sustainability and resource valorization. The preference for supported and porous catalysts has been shown to enhance reaction efficiency significantly, with specific reaction parameters like temperature and time emerging as critical factors for optimizing biocrude production.

The data reveal that optimal reaction conditions vary widely across different catalysts and feedstocks but generally demonstrate a trend towards shorter reaction times and controlled temperatures to maximize biocrude yield. This optimization not only enhances the efficiency of the CHTL process but also contributes to the economic feasibility of renewable energy production from biomass. The study further underscores the potential of CHTL to integrate into existing energy systems, offering a renewable alternative to conventional fossil fuels and aligning with global efforts towards a more sustainable energy landscape.

CHAPTER 6: RECOMMENDATIONS

Based on the findings of this study, several strategic recommendations can be made to advance the field of CHTL. Enhanced development of catalysts is crucial, with a focus on creating more effective catalysts that can operate under a broader range of conditions. There is a particular need for catalysts capable of handling biomass types with high moisture and ash content, which currently hinder efficiency and operational stability. This research and development should aim to overcome these limitations, thereby improving the robustness and applicability of CHTL processes.

In addition to catalyst development, there is a significant need for standardization in reporting the parameters of CHTL studies. This standardization would ensure comparability and reproducibility of results across different research efforts. It is especially important to consistently report on by-products like aqueous phases and gases, which are vital for evaluating the environmental impact and overall efficiency of the liquefaction process.

Lastly, broadening the scope of research into various feedstocks, including exploring the use of a variety of different types of waste materials, can enhance the flexibility and attractiveness of CHTL. This expansion would not only improve the technology's adaptability but also align with circular economy goals by promoting the valorization of waste.

By embracing these recommendations, the potential of Catalytic Hydrothermal Liquefaction to serve as a sustainable and efficient technology for renewable energy production can be fully realized, facilitating a smoother transition towards a more sustainable global energy framework.

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APPENDIX

Feedstock	Elemental Composition (wt% d.b.)						Biochemical Composition (wt.% d.b.)								Operating Condition							Product Distribution (wt.% d.b.)			
	C	H	N	S	O	HHV (MJ/kg)	Lipid	Protein	Cellulose	Hemicellulose	Carbohydate	Lignin	Ash	Solid Loading (g)	Catalyst Type	Catalyst Loading (wt.%)	Temperature (°C)	Time (min)	Heating Rate (°C/min)	Reactor Size (mL)	Reactor Type	Biocrude	Char	Aqueous	Gas
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	0.7	280	45	N/A	250	Batch	26	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	1.25	250	30	N/A	250	Batch	25	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	0.7	250	45	N/A	250	Batch	22	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	0.7	280	45	N/A	250	Batch	24	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	0.7	280	30	N/A	250	Batch	28	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	1.6	280	45	N/A	250	Batch	25	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	0.7	280	45	N/A	250	Batch	25	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	0.7	280	45	N/A	250	Batch	25	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	0.2	280	45	N/A	250	Batch	22	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	0.2	250	30	N/A	250	Batch	26	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	0.15	320	60	N/A	250	Batch	33	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	0.15	250	60	N/A	250	Batch	20	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	1.25	250	60	N/A	250	Batch	24	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	0.15	320	30	N/A	250	Batch	30	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	0.7	320	45	N/A	250	Batch	34	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	1.25	320	30	N/A	250	Batch	32	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	0.7	280	45	N/A	250	Batch	26	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	0.7	280	60	N/A	250	Batch	29	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	0.7	280	45	N/A	250	Batch	26	N/A	N/A	N/A
Spirulina Platensis	62.8	3.87	7.39	0.04	25.9	21.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.5	CeO2	1.25	320	60	N/A	250	Batch	34	N/A	N/A	N/A
Sargassum tenerrimum	32.1	4.7	0.93	1.55	60.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.5	6	CaO	10	280	15	N/A	100	Batch	24	39	N/A	7
Sargassum tenerrimum	32.1	4.7	0.93	1.55	60.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.5	6	CaO/ZrO2	10	280	15	N/A	100	Batch	25.2	38.2	N/A	8
Sargassum tenerrimum	32.1	4.7	0.93	1.55	60.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.5	6	CaO/Al2O3	10	280	15	N/A	100	Batch	18	38.7	N/A	10.4
Sargassum tenerrimum	32.1	4.7	0.93	1.55	60.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.5	6	CaO/CeO	10	280	15	N/A	100	Batch	17.5	40	N/A	7
Sargassum tenerrimum	32.1	4.7	0.93	1.55	60.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.5	6	ZrO2	10	280	15	N/A	100	Batch	22	39	N/A	6
Sargassum tenerrimum	32.1	4.7	0.93	1.55	60.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.5	6	Al2O3	10	280	15	N/A	100	Batch	19.5	38.8	N/A	6.9
Sargassum tenerrimum	32.1	4.7	0.93	1.55	60.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.5	6	CeO2	10	280	15	N/A	100	Batch	20.6	40.3	N/A	6.5
Sargassum tenerrimum	32.1	4.7	0.93	1.55	60.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.5	6	CaO/ZrO2	10	260	15	N/A	100	Batch	18.5	40.5	N/A	5.5
Sargassum tenerrimum	32.1	4.7	0.93	1.55	60.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.5	6	CaO/ZrO2	10	280	15	N/A	100	Batch	25.2	38.2	N/A	7
Sargassum tenerrimum	32.1	4.7	0.93	1.55	60.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.5	6	CaO/ZrO2	10	300	15	N/A	100	Batch	22.3	36.5	N/A	11.5
Sargassum tenerrimum	32.1	4.7	0.93	1.55	60.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.5	6	CaO/ZrO2	5	280	15	N/A	100	Batch	17.5	43.3	N/A	5.2
Sargassum tenerrimum	32.1	4.7	0.93	1.55	60.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.5	6	CaO/ZrO2	10	280	15	N/A	100	Batch	25.2	38	N/A	7
Sargassum tenerrimum	32.1	4.7	0.93	1.55	60.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.5	6	CaO/ZrO2	15	280	15	N/A	100	Batch	20.5	37.5	N/A	7.5
Sargassum tenerrimum	32.1	4.7	0.93	1.55	60.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.5	6	CaO/ZrO2	20	280	15	N/A	100	Batch	20	36.5	N/A	8.7
Sargassum tenerrimum	32.1	4.7	0.93	1.55	60.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.5	6	CaO/ZrO2	25	280	15	N/A	100	Batch	18.3	34.2	N/A	9.1
Sargassum tenerrimum	32.1	4.7	0.93	1.55	60.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.5	6	CaO/ZrO3	25	280	15	N/A	100	Batch	2.5	34	N/A	14
Sargassum tenerrimum	32.1	4.7	0.93	1.55	60.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.5	6	CaO/ZrO4	25	280	15	N/A	100	Batch	33	30	N/A	7
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn	2.5	220	5	10	90	Batch	7.7	52	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn	2.5	240	10	10	90	Batch	11.2	45.5	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn	2.5	260	15	10	90	Batch	17.6	33.5	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn	2.5	280	20	10	90	Batch	25.3	20.5	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn	2.5	300	30	10	90	Batch	29.2	19	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Fe	2.5	220	5	10	90	Batch	15.2	40.2	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Fe	2.5	240	10	10	90	Batch	21.6	34	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Fe	2.5	260	15	10	90	Batch	25.3	23	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Fe	2.5	280	20	10	90	Batch	31.9	11.5	N/A	N/A

Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Fe	2.5	300	30	10	90	Batch	35.2	10.5	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn+Fe	5	220	5	10	90	Batch	8.8	43	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn+Fe	5	240	10	10	90	Batch	12.8	36	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn+Fe	5	260	15	10	90	Batch	20.2	25	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn+Fe	5	280	20	10	90	Batch	28	14	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn+Fe	5	300	30	10	90	Batch	30.8	10.2	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn	2.5	260	30	10	90	Batch	20.62	23.64	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Fe	2.5	260	30	10	90	Batch	23.55	33.78	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn+Fe	5	260	30	10	90	Batch	20.91	18.58	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn	2.5	260	0	10	90	Batch	12.3	37.2	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn	2.5	260	10	10	90	Batch	18.1	27.5	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn	2.5	260	15	10	90	Batch	17.9	32.2	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn	2.5	260	20	10	90	Batch	19.49	37.8	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn	2.5	260	30	10	90	Batch	20.19	23.64	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Fe	2.5	260	0	10	90	Batch	14.4	53.8	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Fe	2.5	260	10	10	90	Batch	26.62	29	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Fe	2.5	260	15	10	90	Batch	25.2	22.55	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Fe	2.5	260	20	10	90	Batch	21.1	28	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Fe	2.5	260	30	10	90	Batch	23.63	34	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn+Fe	5	260	0	10	90	Batch	11	35.9	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn+Fe	5	260	10	10	90	Batch	15	28	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn+Fe	5	260	15	10	90	Batch	17.4	24.8	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn+Fe	5	260	20	10	90	Batch	23.21	18.5	N/A	N/A
Lactuca scariola	43.4	5.65	0.48	0.02	50.45	13.74	N/A	N/A	37.28	31.78	N/A	20.43	4.86	5	Zn+Fe	5	260	30	10	90	Batch	21.36	18.6	N/A	N/A
Food waste	44.5	6.4	3.8	N/A	45.4	24.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100	Fly ash	5	300	60	6	300	Batch	22.9	31.2	7.1	14.2
Food waste	44.5	6.4	3.8	N/A	45.4	24.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100	Red Clay	5	300	60	6	300	Batch	39.5	20	23.5	15
Food waste	44.5	6.4	3.8	N/A	45.4	24.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100	Red Mud	5	300	60	6	300	Batch	47	4	10	17.5
Food waste	44.5	6.4	3.8	N/A	45.4	24.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100	SiO2	5	300	60	6	300	Batch	30	43	7	20
Food waste	44.5	6.4	3.8	N/A	45.4	24.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100	Al2O3	5	300	60	6	300	Batch	29	25.5	27	20.5
Food waste	44.5	6.4	3.8	N/A	45.4	24.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100	Fe2O3	5	300	60	6	300	Batch	22	50.5	8	19.5
Food waste	44.5	6.4	3.8	N/A	45.4	24.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100	CaO	5	300	60	6	300	Batch	20	62	15	3
Sprulina	49.4	6.93	11.83	0.71	31.13	23.24	6	65	N/A	N/A	11	N/A	6.5	60	NiO/SAPO-34	10	270	30	N/A	1000	Batch	59.85	2.5	34	2.6
Sprulina	49.4	6.93	11.83	0.71	31.13	23.24	6	65	N/A	N/A	11	N/A	6.5	60	NiO/ZSM-5	10	270	30	N/A	1000	Batch	58.2	2.4	38.5	2.5
Sprulina	49.4	6.93	11.83	0.71	31.13	23.24	6	65	N/A	N/A	11	N/A	6.5	60	NiO/USY	10	270	30	N/A	1000	Batch	59.12	2.8	37	2.2
Sprulina	49.4	6.93	11.83	0.71	31.13	23.24	6	65	N/A	N/A	11	N/A	6.5	60	NiO/γ-Al2O3	10	270	30	N/A	1000	Batch	57	2.5	40.5	2.4
Sprulina	49.4	6.93	11.83	0.71	31.13	23.24	6	65	N/A	N/A	11	N/A	6.5	60	NiO/SiO2	10	270	30	N/A	1000	Batch	58.5	2.6	39	2.3
Chlorella	50.72	6.89	10.11	1	31.33	22.31	4	56	N/A	N/A	35	N/A	5	4	AB	0.5	280	30	N/A	7	Batch	31.8	N/A	N/A	N/A
Chlorella	50.72	6.89	10.11	1	31.33	22.31	4	56	N/A	N/A	35	N/A	5	4	BA	0.5	280	30	N/A	7	Batch	31.8	N/A	N/A	N/A
Chlorella	50.72	6.89	10.11	1	31.33	22.31	4	56	N/A	N/A	35	N/A	5	4	BB	0.5	280	30	N/A	7	Batch	32.2	N/A	N/A	N/A
Chlorella	50.72	6.89	10.11	1	31.33	22.31	4	56	N/A	N/A	35	N/A	5	4	AA	0.5	280	30	N/A	7	Batch	32	N/A	N/A	N/A
Scenedesmus obliquus	54.12	7.82	6.94	0.46	30.66	23.98	N/A	N/A	N/A	N/A	N/A	N/A	6.12	15	Ca(OH)2	3	240	60	10	250	Batch	19	19	39	23
Scenedesmus obliquus	54.12	7.82	6.94	0.46	30.66	23.98	N/A	N/A	N/A	N/A	N/A	N/A	6.12	15	Ca(OH)2	3	260	60	10	250	Batch	22	18.5	33.5	26
Scenedesmus obliquus	54.12	7.82	6.94	0.46	30.66	23.98	N/A	N/A	N/A	N/A	N/A	N/A	6.12	15	Ca(OH)2	3	280	60	10	250	Batch	22.6	18.4	32	27
Scenedesmus obliquus	54.12	7.82	6.94	0.46	30.66	23.98	N/A	N/A	N/A	N/A	N/A	N/A	6.12	15	Ca(OH)2	3	300	60	10	250	Batch	28.56	17	25.04	25.23
Scenedesmus obliquus	54.12	7.82	6.94	0.46	30.66	23.98	N/A	N/A	N/A	N/A	N/A	N/A	6.12	15	Ca(OH)2	3	320	60	10	250	Batch	24.6	16.4	30	29
Scenedesmus obliquus	54.12	7.82	6.94	0.46	30.66	23.98	N/A	N/A	N/A	N/A	N/A	N/A	6.12	15	Ca(OH)2	0.2	300	60	10	250	Batch	29.5	15	38	26
Scenedesmus obliquus	54.12	7.82	6.94	0.46	30.66	23.98	N/A	N/A	N/A	N/A	N/A	N/A	6.12	15	Ca(OH)2	0.4	300	60	10	250	Batch	33.5	14	23	30
Scenedesmus obliquus	54.12	7.82	6.94	0.46	30.66	23.98	N/A	N/A	N/A	N/A	N/A	N/A	6.12	15	Ca(OH)2	0.6	300	60	10	250	Batch	39.6	13.2	15	32
Scenedesmus obliquus	54.12	7.82	6.94	0.46	30.66	23.98	N/A	N/A	N/A	N/A	N/A	N/A	6.12	15	Ca(OH)2	0.8	300	60	10	250	Batch	38	14	14.5	33
Scenedesmus obliquus	54.12	7.82	6.94	0.46	30.66	23.98	N/A	N/A	N/A	N/A	N/A	N/A	6.12	15	Ca(OH)2	1	300	60	10	250	Batch	37.1	14.5	14.6	25

Ulva prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.2	N/A	ZSM-5	10	280	10	10	100	Batch	20.2	28.2	29.3	22.3
Ulva prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.2	N/A	ZSM-5	15	280	10	10	100	Batch	29.3	26.4	20.2	24.1
Ulva prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.2	N/A	ZSM-5	20	280	10	10	100	Batch	24.8	25.2	25.2	24.8
Ulva prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.2	N/A	Y-Zeolite	10	280	10	10	100	Batch	19.4	30.2	31.6	18.8
Ulva prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.2	N/A	Y-Zeolite	15	280	10	10	100	Batch	20.6	29.3	30.9	19.2
Ulva prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.2	N/A	Y-Zeolite	20	280	10	10	100	Batch	23.4	29.8	26.8	20
Ulva prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.2	N/A	Mordenite	10	280	10	10	100	Batch	18.2	31	31.5	19.3
Ulva prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.2	N/A	Mordenite	15	280	10	10	100	Batch	24.1	28.4	27.3	20.2
Ulva prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.2	N/A	Mordenite	20	280	10	10	100	Batch	23.2	27.1	28.5	21.2
Glycyrrhiza glabra L	45.13	6.24	0.6	0	48.03	15.61	N/A	N/A	38.49	27.76	N/A	26.68	3.04	5	H3BO3	10	250	N/A	10	N/A	Batch	19.95	39	N/A	N/A
Glycyrrhiza glabra L	45.13	6.24	0.6	0	48.03	15.61	N/A	N/A	38.49	27.76	N/A	26.68	3.04	5	H3BO4	10	300	N/A	10	N/A	Batch	33.48	14.08	N/A	N/A
Glycyrrhiza glabra L	45.13	6.24	0.6	0	48.03	15.61	N/A	N/A	38.49	27.76	N/A	26.68	3.04	5	H3BO5	10	350	N/A	10	N/A	Batch	35.73	10.88	N/A	N/A
Glycyrrhiza glabra L	45.13	6.24	0.6	0	48.03	15.61	N/A	N/A	38.49	27.76	N/A	26.68	3.04	5	ZnO	10	250	N/A	10	N/A	Batch	13.88	52.92	N/A	N/A
Glycyrrhiza glabra L	45.13	6.24	0.6	0	48.03	15.61	N/A	N/A	38.49	27.76	N/A	26.68	3.04	5	ZnO	10	300	N/A	10	N/A	Batch	25.81	24.44	N/A	N/A
Glycyrrhiza glabra L	45.13	6.24	0.6	0	48.03	15.61	N/A	N/A	38.49	27.76	N/A	26.68	3.04	5	ZnO	10	350	N/A	10	N/A	Batch	30.04	20.67	N/A	N/A
Ulva Prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.3	14.29	MgO	10	280	15	N/A	100	Batch	35.1	29.2	22.1	15.8
Ulva Prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.3	14.29	CaO	10	280	15	N/A	100	Batch	26.8	32.8	21.2	18.3
Ulva Prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.3	14.29	CaCO3	10	280	15	N/A	100	Batch	24.5	30.4	24.2	22.4
Ulva Prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.3	14.29	Al2O3	10	280	15	N/A	100	Batch	26.8	30.2	30.6	18.8
Ulva Prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.3	14.29	ZrO2	10	280	15	N/A	100	Batch	20.4	29.8	30.2	18.2
Ulva Prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.3	14.29	CeO2	10	280	15	N/A	100	Batch	22.2	28.8	28.9	19.3
Ulva Prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.3	14.29	CuCl2	10	280	15	N/A	100	Batch	26.3	32.1	30.4	18.3
Ulva Prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.3	14.29	FeCl3	10	280	15	N/A	100	Batch	23.1	29.8	26.3	19.2
Ulva Prolifera	46.2	7.4	3	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.3	14.29	MgCl2	10	280	15	N/A	100	Batch	28.2	27.1	27.5	16.2
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Fe	10	260	15	60	10	Batch	21	9.5	N/A	19
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Fe	10	280	15	60	10	Batch	26	15.5	N/A	17.5
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Fe	10	300	15	60	10	Batch	32	19.5	N/A	14
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Fe	10	320	15	60	10	Batch	39.9	21	N/A	5.5
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Fe3O4	10	260	15	60	10	Batch	18	18	N/A	25.2
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Fe3O5	10	280	15	60	10	Batch	24	19.5	N/A	21
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Fe3O6	10	300	15	60	10	Batch	29	23.5	N/A	17.2
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Fe3O7	10	320	15	60	10	Batch	32	23	N/A	12.5
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Fe2O3	10	260	15	60	10	Batch	16.5	7	N/A	28
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Fe2O4	10	280	15	60	10	Batch	22	10.2	N/A	25
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Fe2O5	10	300	15	60	10	Batch	24.5	12.5	N/A	20
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Fe2O6	10	320	15	60	10	Batch	27.5	14	N/A	20.5
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Ni	10	280	15	60	10	Batch	24.58	23	N/A	11
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Ni	10	300	15	60	10	Batch	30.5	19	N/A	13.4
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Ni	10	320	15	60	10	Batch	32.5	16.8	N/A	15
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Ni	10	330	15	60	10	Batch	33.68	14.52	N/A	16
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Ni	10	330	10	60	10	Batch	35.05	13.8	N/A	14.6
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Ni	10	330	15	60	10	Batch	33.8	14.6	N/A	15.8
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Ni	10	330	30	60	10	Batch	29.19	17.3	N/A	17.1
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Ni spiked	10	330	10	60	10	Batch	36.63	13.02	N/A	15.95
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Ni	0.2	330	10	60	10	Batch	35.75	12.39	N/A	15.47
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	N/A	0.3	330	10	60	10	Batch	36.53	11.77	N/A	16.05
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	N/A	0.5	330	10	60	10	Batch	37.87	9.47	N/A	17.09
Oak wood	50.2	7	N/A	N/A	42.8	13.2	N/A	N/A	38.1	23	N/A	32	2	1	Ni spiked	0.3	330	10	60	10	Batch	37.78	11.22	N/A	16.79
Ulva lactuna	44.2	5.7	2	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.9	6	MgO-E	10	280	30	5	10	Batch	46.7	29.2	8.3	15.8
Ulva lactuna	44.2	5.7	2	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.9	6	MgO-E-FA	10	280	30	5	10	Batch	55.2	15.8	14.7	14.3

Ulva lactuna	44.2	5.7	2	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.9	6	ZSM-5-E	10	280	30	5	10	Batch	44.1	22.4	15.1	18.4
Ulva lactuna	44.2	5.7	2	0.2	43.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.9	6	SESM-5-E-FA	10	280	30	5	10	Batch	48.7	20.3	11.8	19.2
Peanut shell	48.2	7.1	2	0.2	42.5	18.2	N/A	N/A	28.1	41.2	N/A	20.4	8.4	5	MgO	N/A	290	30	10	N/A	Batch	31.2	39.5	N/A	29.3
Peanut shell	48.2	7.1	2	0.2	42.5	18.2	N/A	N/A	28.1	41.2	N/A	20.4	8.4	5	ZSM-5	N/A	290	30	10	N/A	Batch	25.5	39.7	N/A	25.8
Peanut shell	48.2	7.1	2	0.2	42.5	18.2	N/A	N/A	28.1	41.2	N/A	20.4	8.4	5	MgO-ZSM-5	N/A	290	30	10	N/A	Batch	40.6	34.9	N/A	24.5
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	AC	10	290	15	N/A	N/A	Batch	24.1	N/A	N/A	8.7
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	Ni/AC	10	290	15	N/A	N/A	Batch	25.6	N/A	N/A	9.3
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	Co/AC	10	290	15	N/A	N/A	Batch	24.5	N/A	N/A	10.4
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	Ni-Co/AC	10	290	15	N/A	N/A	Batch	26.7	N/A	N/A	10.6
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	AC	10	290	15	N/A	N/A	Batch	68.3	N/A	N/A	12.6
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	Ni/AC	10	290	15	N/A	N/A	Batch	69.3	N/A	N/A	13.1
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	Co/AV	10	290	15	N/A	N/A	Batch	67.2	N/A	N/A	13.5
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	Ni-Co/AC	10	290	15	N/A	N/A	Batch	72	N/A	N/A	12.8
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	AC	10	290	15	N/A	N/A	Batch	67.8	N/A	N/A	13.8
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	Ni/AC	10	290	15	N/A	N/A	Batch	67.7	N/A	N/A	14.2
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	Co/AC	10	290	15	N/A	N/A	Batch	70.5	N/A	N/A	14.2
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	Ni-Co/AC	10	290	15	N/A	N/A	Batch	65.9	N/A	N/A	14.2
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	Ni-Co/AC	10	260	15	N/A	N/A	Batch	64.1	N/A	N/A	12.1
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	Ni-Co/AC	10	280	15	N/A	N/A	Batch	72	N/A	N/A	12.8
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	Ni-Co/AC	10	300	15	N/A	N/A	Batch	67.7	N/A	N/A	17.8
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	Ni-Co/AC	5	280	15	N/A	N/A	Batch	69	N/A	N/A	12.5
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	Ni-Co/AC	10	280	15	N/A	N/A	Batch	72	N/A	N/A	12.8
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	Ni-Co/AC	15	280	15	N/A	N/A	Batch	70	N/A	N/A	14.5
Alkali lignin	60	7.8	0.2	2.7	29.3	26.5	N/A	N/A	N/A	N/A	N/A	N/A	2.6	6	Ni-Co/AC	20	280	15	N/A	N/A	Batch	67.9	N/A	N/A	16.9
Spirulina	42.7	7.4	5.6	N/A	45.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Ni/CNT	20	290	30	10	N/A	Batch	33.2	39.5	N/A	27.3
Spirulina	42.7	7.4	5.6	N/A	45.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Fe/CNT	20	290	30	10	N/A	Batch	38.5	36.7	N/A	24.8
Spirulina	42.7	7.4	5.6	N/A	45.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Co/CNT	20	290	30	10	N/A	Batch	43.6	33.9	N/A	22.5
Spirulina	42.7	7.4	5.6	N/A	45.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Co/CNT	20	290	30	10	N/A	Batch	21.6	48	N/A	16.8
Spirulina	42.7	7.4	5.6	N/A	45.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Co/CNT	20	290	30	10	N/A	Batch	43.6	33.9	N/A	22.5
Spirulina	42.7	7.4	5.6	N/A	45.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	CO/CNT	20	290	30	10	N/A	Batch	39.7	32.4	N/A	27.9
Spirulina	42.7	7.4	5.6	N/A	45.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Co/CNT	20	270	30	10	N/A	Batch	36.8	42.1	N/A	18.1
Spirulina	42.7	7.4	5.6	N/A	45.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Co/CNT	20	290	30	10	N/A	Batch	43.6	33.9	N/A	22.5
Spirulina	42.7	7.4	5.6	N/A	45.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Co/CNT	20	210	30	10	N/A	Batch	42.7	32.1	N/A	25.2
Municipal sludge	43.39	6.48	5.04	0.8	44.29	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	CoMo/Al2O3	10	325	30	13	16	Batch	35.5	22.5	N/A	8
Municipal sludge	43.39	6.48	5.04	0.8	44.29	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	NiMo/Al2O3	10	325	30	13	16	Batch	30.5	35	N/A	2
Municipal sludge	43.39	6.48	5.04	0.8	44.29	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	ACF 2600	10	325	30	13	16	Batch	35	25	N/A	6
Municipal sludge	43.39	6.48	5.04	0.8	44.29	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	CoMo/Al2O3	30	325	30	13	16	Batch	36	15	N/A	8
Municipal sludge	43.39	6.48	5.04	0.8	44.29	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	NiMo/Al2O3	30	325	30	13	16	Batch	52.5	30	N/A	6
Municipal sludge	43.39	6.48	5.04	0.8	44.29	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	ACF 2600	30	325	30	13	16	Batch	52	25	N/A	11
Chlorella sp	50.72	6.89	10.11	1	31.33	22.31	4	56	N/A	N/A	35	N/A	5	0.5	Straw biochar	N/A	350	30	10	4	Batch	27.5	N/A	N/A	N/A
Chlorella sp	50.72	6.89	10.11	1	31.33	22.31	4	56	N/A	N/A	35	N/A	5	0.5	Rice husk biochar	N/A	350	30	10	4	Batch	27.4	N/A	N/A	N/A
Chlorella sp	50.72	6.89	10.11	1	31.33	22.31	4	56	N/A	N/A	35	N/A	5	0.5	Peanut shell biochar	N/A	350	30	10	4	Batch	29.4	N/A	N/A	N/A
Chlorella sp	50.72	6.89	10.11	1	31.33	22.31	4	56	N/A	N/A	35	N/A	5	0.5	Sawdust biochar	N/A	350	30	10	4	Batch	28	N/A	N/A	N/A
Kraft lignin	61	7	1.7	2	28.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	1	MCM-41	10	280	60	5	50	Batch	44.2	30.5	N/A	25.3
Kraft lignin	61	7	1.7	2	28.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	1	Ni/MCM-41	10	280	60	5	50	Batch	62.2	21.7	N/A	16.1
Kraft lignin	61	7	1.7	2	28.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	1	Al/MCM-41	10	280	60	5	50	Batch	57.6	27.9	N/A	14.5
Kraft lignin	61	7	1.7	2	28.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	1	Ni-Al/MCM-41	10	280	60	5	50	Batch	67.2	18.4	N/A	14.4
Kraft lignin	61	7	1.7	2	28.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	1	Ni-Al/MCM-41	10	250	60	5	50	Batch	56.8	29.1	N/A	14.1
Kraft lignin	61	7	1.7	2	28.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	1	Ni-Al/MCM-41	10	280	60	5	50	Batch	67.2	18.4	N/A	14.4
Kraft lignin	61	7	1.7	2	28.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	1	Ni-Al/MCM-41	10	310	60	5	50	Batch	64.3	13.1	N/A	22.6

Kraft lignin	61	7	1.7	2	28.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	1	Ni-Al/MCM-41	10	280	30	5	50	Batch	57.1	31	N/A	12
Kraft lignin	61	7	1.7	2	28.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	1	Ni-Al/MCM-41	10	280	60	5	50	Batch	67.2	18.4	N/A	17
Kraft lignin	61	7	1.7	2	28.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	1	Ni-Al/MCM-41	10	280	90	5	50	Batch	57.6	29.1	N/A	16.5
Kraft lignin	61	7	1.7	2	28.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	1	Ni-Al/MCM-41	10	280	60	5	50	Batch	39.6	33.2	N/A	23.8
Kraft lignin	61	7	1.7	2	28.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	1	Ni-Al/MCM-41	10	280	60	5	50	Batch	67.2	18.4	N/A	14.4
Kraft lignin	61	7	1.7	2	28.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	1	Ni-Al/MCM-41	10	280	60	5	50	Batch	59.6	19.5	N/A	19.9
Kraft lignin	61	7	1.7	2	28.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	1	Ni-Al/MCM-41	10	280	60	5	50	Batch	62.6	17.6	N/A	19.8
Kraft lignin	61	7	1.7	2	28.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	1	Ni-Al/MCM-41	10	280	60	5	50	Batch	67.2	18.4	N/A	14.4
Kraft lignin	61	7	1.7	2	28.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	1	Ni-Al/MCM-41	10	280	60	5	50	Batch	61.6	25.5	N/A	12.9
Untreate wood	46.65	6.38	0.68	0.01	46.28	19.64	N/A	N/A	N/A	N/A	N/A	N/A	0.35	1.49	K2CO3	2	400	15	N/A	10	Batch	36.35	10.64	N/A	N/A
Non-hazardous wood	47.99	6.55	0.59	0.03	44.84	20.59	N/A	N/A	N/A	N/A	N/A	N/A	0.81	N/A	K2CO3	2	400	15	N/A	10	Batch	32.93	12.34	N/A	N/A
Hazardous wood	49.73	6.72	0.75	0.02	42.78	22.25	N/A	N/A	N/A	N/A	N/A	N/A	2.18	N/A	K2CO3	2	400	15	N/A	10	Batch	28.22	13	N/A	N/A
mixed wood	47.9	6.52	0.71	0.02	44.85	19.68	N/A	N/A	N/A	N/A	N/A	N/A	0.59	N/A	K2CO3	2	400	15	N/A	10	Batch	24.86	22	N/A	N/A
Spirulina Platensis	46.5	7.1	10.8	0.7	34.9	19.3	8.3	N/A	N/A	N/A	15.2	N/A	6.3	3	Na2CO3	5	350	60	N/A	25	Batch	47.8	4.9	32.5	14.7
Spirulina Platensis	46.5	7.1	10.8	0.7	34.9	19.3	8.3	N/A	N/A	N/A	15.2	N/A	6.3	3	Pt/Al2O3	5	350	60	N/A	25	Batch	43.7	4.2	35.2	17
Spirulina Platensis	46.5	7.1	10.8	0.7	34.9	19.3	8.3	N/A	N/A	N/A	15.2	N/A	6.3	3	Na2CO3	5	300	60	N/A	25	Batch	31.7	6.5	50.2	11.6
Spirulina Platensis	46.5	7.1	10.8	0.7	34.9	19.3	8.3	N/A	N/A	N/A	15.2	N/A	6.3	3	Pt/Al2O3	5	300	60	N/A	25	Batch	28.5	5.8	53.2	12.5
Kraft lignin	58.7	5.6	0.6	3.4	31.7	25.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	CNT	20	280	30	10	N/A	Batch	45.2	29.5	N/A	25.3
Kraft lignin	58.7	5.6	0.6	3.4	31.7	25.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Ni/CNT	20	280	30	10	N/A	Batch	62.5	21.7	N/A	15.8
Kraft lignin	58.7	5.6	0.6	3.4	31.7	25.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Fe/CNT	20	280	30	10	N/A	Batch	56.6	28.9	N/A	14.5
Kraft lignin	58.7	5.6	0.6	3.4	31.7	25.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Co/CNT	20	280	30	10	N/A	Batch	66.2	18.4	N/A	15.4
Kraft lignin	58.7	5.6	0.6	3.4	31.7	25.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Co/CNT	20	280	30	10	N/A	Batch	40.6	32.2	N/A	23.8
Kraft lignin	58.7	5.6	0.6	3.4	31.7	25.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Co/CNT	20	280	30	10	N/A	Batch	66.2	18.4	N/A	15.4
Kraft lignin	58.7	5.6	0.6	3.4	31.7	25.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Co/CNT	20	280	30	10	N/A	Batch	61.6	19.5	N/A	18.9
Kraft lignin	58.7	5.6	0.6	3.4	31.7	25.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Co/CNT	20	260	30	10	N/A	Batch	56.8	29.1	N/A	14.1
Kraft lignin	58.7	5.6	0.6	3.4	31.7	25.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Co/CNT	20	280	30	10	N/A	Batch	66.2	18.4	N/A	15.4
Kraft lignin	58.7	5.6	0.6	3.4	31.7	25.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Co/CNT	20	300	30	10	N/A	Batch	64.7	13.1	N/A	22.2
Gracilaria corticata	35.5	5.2	7.5	2.4	52	13.1	N/A	N/A	N/A	N/A	N/A	N/A	18.7	6	NiFe-LDH	N/A	280	30	10	N/A	Batch	35.2	39.5	N/A	25.3
Gracilaria corticata	35.5	5.2	7.5	2.4	52	13.1	N/A	N/A	N/A	N/A	N/A	N/A	18.7	6	NiFe-LDO	N/A	280	30	10	N/A	Batch	42.5	38.7	N/A	18.8
Gracilaria corticata	35.5	5.2	7.5	2.4	52	13.1	N/A	N/A	N/A	N/A	N/A	N/A	18.7	6	NiFe-LDO/AC	N/A	280	30	10	N/A	Batch	46.6	38.9	N/A	14.5
Gracilaria corticata	35.5	5.2	7.5	2.4	52	13.1	N/A	N/A	N/A	N/A	N/A	N/A	18.7	6	Ga5/NiFe-LDO/AC	N/A	280	30	10	N/A	Batch	56.2	28.4	N/A	15.4
Gracilaria corticata	35.5	5.2	7.5	2.4	52	13.1	N/A	N/A	N/A	N/A	N/A	N/A	18.7	6	Ga10/NiFe-LDO/AC	N/A	280	30	10	N/A	Batch	51.3	30.2	N/A	18.5
Gracilaria corticata	35.5	5.2	7.5	2.4	52	13.1	N/A	N/A	N/A	N/A	N/A	N/A	18.7	6	5Ga/NiFe-LDO/AC	N/A	280	30	10	N/A	Batch	35.6	38.1	N/A	16.8
Gracilaria corticata	35.5	5.2	7.5	2.4	52	13.1	N/A	N/A	N/A	N/A	N/A	N/A	18.7	6	5Ga/NiFe-LDO/AC	N/A	280	30	10	N/A	Batch	56.2	28.3	N/A	15.4
Gracilaria corticata	35.5	5.2	7.5	2.4	52	13.1	N/A	N/A	N/A	N/A	N/A	N/A	18.7	6	5Ga/NiFe-LDO/AC	N/A	280	30	10	N/A	Batch	49.7	25.5	N/A	20.9
Gracilaria corticata	35.5	5.2	7.5	2.4	52	13.1	N/A	N/A	N/A	N/A	N/A	N/A	18.7	6	5Ga/NiFe-LDO/AC	N/A	260	30	10	N/A	Batch	36.8	49.1	N/A	14.1
Gracilaria corticata	35.5	5.2	7.5	2.4	52	13.1	N/A	N/A	N/A	N/A	N/A	N/A	18.7	6	5Ga/NiFe-LDO/AC	N/A	280	30	10	N/A	Batch	56.2	28.4	N/A	15.4
Gracilaria corticata	35.5	5.2	7.5	2.4	52	13.1	N/A	N/A	N/A	N/A	N/A	N/A	18.7	6	5Ga/NiFe-LDO/AC	N/A	300	30	10	N/A	Batch	52.7	22.1	N/A	25.2
Gracilaria corticata	35.5	5.2	7.5	2.4	52	13.1	N/A	N/A	N/A	N/A	N/A	N/A	18.7	6	5Ga/NiFe-LDO/AC	5	280	30	10	N/A	Batch	40.6	45.6	N/A	13.8
Gracilaria corticata	35.5	5.2	7.5	2.4	52	13.1	N/A	N/A	N/A	N/A	N/A	N/A	18.7	6	5Ga/NiFe-LDO/AC	10	280	30	10	N/A	Batch	46.2	39.6	N/A	14.2
Gracilaria corticata	35.5	5.2	7.5	2.4	52	13.1	N/A	N/A	N/A	N/A	N/A	N/A	18.7	6	5Ga/NiFe-LDO/AC	15	280	30	10	N/A	Batch	56.2	28.4	N/A	15.4
Gracilaria corticata	35.5	5.2	7.5	2.4	52	13.1	N/A	N/A	N/A	N/A	N/A	N/A	18.7	6	5Ga/NiFe-LDO/AC	20	280	30	10	N/A	Batch	54.6	22.3	N/A	23.1
Gracilaria corticata	35.5	5.2	7.5	2.4	52	13.1	N/A	N/A	N/A	N/A	N/A	N/A	18.7	6	5Ga/NiFe-LDO/AC	25	280	30	10	N/A	Batch	51.3	21.2	N/A	27.5
Food waste	47.2	6.7	4.6	0	41.5	24.6	21.9	17.8	N/A	N/A	58.9	N/A	1.1	15	CeO2	33	300	60	6	300	Batch	35	23	19	11
Food waste	47.2	6.7	4.6	0	41.5	24.6	21.9	17.8	N/A	N/A	58.9	N/A	1.1	15	ZrO2	33	300	60	6	300	Batch	34	24	20	14
Food waste	47.2	6.7	4.6	0	41.5	24.6	21.9	17.8	N/A	N/A	58.9	N/A	1.1	15	CeZrOx	33	300	60	6	300	Batch	39	16	22	17
Food waste	47.2	6.7	4.6	0	41.5	24.6	21.9	17.8	N/A	N/A	58.9	N/A	1.1	15	Ni/CeO2	36.7	300	60	6	300	Batch	37	9.5	31	5.5
Food waste	47.2	6.7	4.6	0	41.5	24.6	21.9	17.8	N/A	N/A	58.9	N/A	1.1	15	Ni/ZrO2	36.7	300	60	6	300	Batch	41	2	34	8
Food waste	47.2	6.7	4.6	0	41.5	24.6	21.9	17.8	N/A	N/A	58.9	N/A	1.1	15	Ni/CeZrOx	36.7	300	60	6	300	Batch	42	7	28	20
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	HCOOH	5	280	180	N/A	N/A	Batch	29	13.5	N/A	N/A

Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	CH3COOH	5	280	180	N/A	N/A	Batch	28.17	14	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	Na2CO3	5	280	180	N/A	N/A	Batch	31.29	12.5	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	K2CO3	5	280	180	N/A	N/A	Batch	31	14	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	NaOH	5	280	180	N/A	N/A	Batch	31	13.5	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	KOH	5	280	180	N/A	N/A	Batch	30	13.5	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	ZSM-5	5	280	180	N/A	N/A	Batch	33.5	11	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	ZSM-22	5	280	180	N/A	N/A	Batch	31.91	12	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	ZSM-35	5	280	180	N/A	N/A	Batch	32.5	11.5	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	MCM-41	5	280	180	N/A	N/A	Batch	36	10.5	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	MCM-48	5	280	180	N/A	N/A	Batch	36.44	10	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	Na2CO3	1	280	180	N/A	N/A	Batch	27.21	13.85	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	Na2CO4	3	280	180	N/A	N/A	Batch	29.86	13.04	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	Na2CO5	5	280	180	N/A	N/A	Batch	31.29	11.75	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	Na2CO6	8	280	180	N/A	N/A	Batch	31.44	11.99	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	Na2CO7	10	280	180	N/A	N/A	Batch	30.35	11.64	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	NaOH	1	280	180	N/A	N/A	Batch	28.4	13.16	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	NaOH	3	280	180	N/A	N/A	Batch	30.91	12.32	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	NaOH	5	280	180	N/A	N/A	Batch	30.83	12.09	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	NaOH	8	280	180	N/A	N/A	Batch	29.33	12.25	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	NaOH	10	280	180	N/A	N/A	Batch	27.65	12.73	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	ZSSM-5	1	280	180	N/A	N/A	Batch	28.54	14.07	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	ZSSM-6	3	280	180	N/A	N/A	Batch	33.26	13.33	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	ZSSM-7	5	280	180	N/A	N/A	Batch	33.18	11.37	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	ZSSM-8	8	280	180	N/A	N/A	Batch	34.53	10.03	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	ZSSM-9	10	280	180	N/A	N/A	Batch	33.89	10.42	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	MCM-48	1	280	180	N/A	N/A	Batch	29.76	12.34	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	MCM-49	3	280	180	N/A	N/A	Batch	35.23	10.33	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	MCM-50	5	280	180	N/A	N/A	Batch	36.44	10.19	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	MCM-51	8	280	180	N/A	N/A	Batch	35.15	10.15	N/A	N/A
Penicillin	44.88	6.27	5.93	0.77	34.12	N/A	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	MCM-52	10	280	180	N/A	N/A	Batch	34.69	9.75	N/A	N/A
Oily sludge	28.83	5.84	1.37	0.3	63.66	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	TiO2	1	230	30	N/A	3	Batch	3.369	19.82	0.311	0.814
Oily sludge	28.83	5.84	1.37	0.3	63.66	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	TiO2	1	230	30	N/A	4	Batch	7.529	16.599	1.679	1.378
Oily sludge	28.83	5.84	1.37	0.3	63.66	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	TiO2	1	250	30	N/A	5	Batch	5.588	15.802	1.175	1.521
Oily sludge	28.83	5.84	1.37	0.3	63.66	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	TiO2	0.1	230	30	N/A	6	Batch	5.388	17.426	N/A	0.947
Oily sludge	28.83	5.84	1.37	0.3	63.66	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	TiO2	1.5	230	30	N/A	7	Batch	12.906	13.876	N/A	1.871
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Ni/C	51.3	350	40	N/A	4.1	Batch	38	N/A	12	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Pt/C	51.3	350	40	N/A	4.1	Batch	27.5	N/A	13	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Ru/C	51.3	350	40	N/A	4.1	Batch	26	N/A	9	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Pd/C	51.3	350	40	N/A	4.1	Batch	25.5	N/A	7	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Act Char	51.3	350	40	N/A	4.1	Batch	26.5	N/A	10.5	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Ni/SiO2-Al2O3	51.3	350	40	N/A	4.1	Batch	32.5	N/A	10	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Pt/Al2O3	51.3	350	40	N/A	4.1	Batch	42	N/A	12	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Ru/Al2O3	51.3	350	40	N/A	4.1	Batch	37	N/A	12.5	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Pd/Al2O3	51.3	350	40	N/A	4.1	Batch	41	N/A	9.5	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Ni/C (3500kPa H2)	51.3	350	40	N/A	4.1	Batch	23	N/A	8	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Pt/C (3500kPa H2)	51.3	350	40	N/A	4.1	Batch	10	N/A	5	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Ru/C (3500kPa H2)	51.3	350	40	N/A	4.1	Batch	8	N/A	5.5	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Pd/C (3500kPa H2)	51.3	350	40	N/A	4.1	Batch	18	N/A	6	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Act Char (3500kPa H2)	51.3	350	40	N/A	4.1	Batch	26	N/A	6	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Ni/SiO2-Al2O3 (3500kPa H2)	51.3	350	40	N/A	4.1	Batch	30	N/A	7	N/A

Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Pt/Al2O3 (3500kPa H2)	51.3	350	40	N/A	4.1	Batch	32	N/A	6.5	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Ru/Al2O3 (3500kPa H2)	51.3	350	40	N/A	4.1	Batch	30	N/A	6	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Pd/Al2O3 (3500kPa H2)	51.3	350	40	N/A	4.1	Batch	33	N/A	5.7	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	CaO	51.3	350	40	N/A	4.1	Batch	32	28	17	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	Al2O3	51.3	350	40	N/A	4.1	Batch	41	3	9	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	CeO2	51.3	350	40	N/A	4.1	Batch	45	11	9	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	La2O3	51.3	350	40	N/A	4.1	Batch	47	12	15	N/A
Food waste	47.8	5.11	4.78	0.23	42.1	N/A	15.7	27.5	N/A	N/A	36.5	N/A	N/A	0.23	SiO2	51.3	350	40	N/A	4.1	Batch	49	N/A	9	N/A
Spirulina platensis	46.9	6.9	10.7	0	35.5	18.5	5.8	70.3	N/A	N/A	N/A	N/A	N/A	3	BC	10	240	35	13	50	Batch	22	10	N/A	N/A
Spirulina platensis	46.9	6.9	10.7	0	35.5	18.5	5.8	70.3	N/A	N/A	N/A	N/A	N/A	3	BC	10	260	35	13	50	Batch	30	8	N/A	N/A
Spirulina platensis	46.9	6.9	10.7	0	35.5	18.5	5.8	70.3	N/A	N/A	N/A	N/A	N/A	3	BC	10	280	35	13	50	Batch	35	4.5	N/A	N/A
Spirulina platensis	46.9	6.9	10.7	0	35.5	18.5	5.8	70.3	N/A	N/A	N/A	N/A	N/A	3	BC	10	300	35	13	50	Batch	37	2	N/A	N/A
Spirulina platensis	46.9	6.9	10.7	0	35.5	18.5	5.8	70.3	N/A	N/A	N/A	N/A	N/A	3	BC	10	320	35	13	50	Batch	36	4	N/A	N/A
Spirulina platensis	46.9	6.9	10.7	0	35.5	18.5	5.8	70.3	N/A	N/A	N/A	N/A	N/A	3	BC	10	340	35	13	50	Batch	34	7	N/A	N/A
Spirulina platensis	46.9	6.9	10.7	0	35.5	18.5	5.8	70.3	N/A	N/A	N/A	N/A	N/A	3	Co/BC	5	280	35	13	50	Batch	32	5	N/A	N/A
Spirulina platensis	46.9	6.9	10.7	0	35.5	18.5	5.8	70.3	N/A	N/A	N/A	N/A	N/A	3	CoOx?BC	5	280	35	13	50	Batch	35.54	2.46	N/A	N/A
Spirulina platensis	46.9	6.9	10.7	0	35.5	18.5	5.8	70.3	N/A	N/A	N/A	N/A	N/A	3	Ni/BC	5	280	35	13	50	Batch	36.57	3.43	N/A	N/A
Spirulina platensis	46.9	6.9	10.7	0	35.5	18.5	5.8	70.3	N/A	N/A	N/A	N/A	N/A	3	NiO/BC	5	280	35	13	50	Batch	34.14	3.86	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe	5	300	30	10	100	Batch	34	19	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe	10	300	30	10	100	Batch	37	15	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe	15	300	30	10	100	Batch	37.5	13.5	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe	20	300	30	10	100	Batch	37	14	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe	25	300	30	10	100	Batch	37	14	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe2O3	14.25	300	30	10	100	Batch	24.56	44.44	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe3O4	13.75	300	30	10	100	Batch	25.49	33.51	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe2O3+H2	14.25	300	30	10	100	Batch	27	36	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe3O4+J2	13.75	300	30	10	100	Batch	28	34	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Na2CO3	10	300	30	10	100	Batch	37.68	21.32	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	NaOH	10	300	30	10	100	Batch	34.48	26.52	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	FeSO4	10	300	30	10	100	Batch	32.39	29.11	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	MgO	10	300	30	10	100	Batch	26.88	35.12	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Ru/C	10	300	30	10	100	Batch	28.99	32.71	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	FeS	10	300	30	10	100	Batch	34.37	22.63	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe+Na2CO3	20	300	30	10	100	Batch	48.24	9.76	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe+NaOH	20	300	30	10	100	Batch	45.81	13.99	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe+FeSO4	20	300	30	10	100	Batch	36.49	22.01	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe+MgO	20	300	30	10	100	Batch	35.25	17.75	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe+Ru/C	20	300	30	10	100	Batch	38.33	15.67	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe+FeSO4	20	300	30	10	100	Batch	46.12	6.88	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-Na2CO3 (10:0)	10	300	30	10	100	Batch	38	17	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-Na2CO3(7.5:2.5)	10	300	30	10	100	Batch	40	15.5	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-Na2CO3 (5:5)	10	300	30	10	100	Batch	45	15	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-Na2CO3 (2.5:7.5)	10	300	30	10	100	Batch	42	18	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-Na2CO3(0:10)	10	300	30	10	100	Batch	39	20	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-NaOH (10:0)	10	300	30	10	100	Batch	38	19	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-NaOH(7.5:2.5)	10	300	30	10	100	Batch	39	19	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-NaOH(7.5:2.5)	10	300	30	10	100	Batch	41	18	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-NaOH(7.5:2.5)	10	300	30	10	100	Batch	38	21.2	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-NaOH(7.5:2.5)	10	300	30	10	100	Batch	37	24	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-FeS (10:0)	10	300	30	10	100	Batch	38	17	N/A	N/A

Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-FeS(7.5:2.5)	10	300	30	10	100	Batch	40	16	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-FeS (5:5)	10	300	30	10	100	Batch	42	13.5	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-FeS (2.5:7.5)	10	300	30	10	100	Batch	39	19	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-FeS(0:10)	10	300	30	10	100	Batch	37	18.5	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-Ru/C (10:0)	10	300	30	10	100	Batch	38	17	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-Ru/C(7.5:2.5)	10	300	30	10	100	Batch	37.5	18.5	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-Ru/C (5:5)	10	300	30	10	100	Batch	33	27	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-Ru/C (2.5:7.5)	10	300	30	10	100	Batch	30	30.6	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Fe-Ru/C(0:10)	10	300	30	10	100	Batch	29	32	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Na2CO3	10	300	30	10	100	Batch	38	21	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Na2CO3+H2	10	300	30	10	100	Batch	38	19	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	NaOH	10	300	30	10	100	Batch	35	26	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	NaOH+H2	10	300	30	10	100	Batch	37	23.5	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	FeS	10	300	30	10	100	Batch	33	22	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	FeS+H2	10	300	30	10	100	Batch	38.5	12.5	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Ru/C	10	300	30	10	100	Batch	30	32	N/A	N/A
Pinewood Sawdust	51.26	5.53	0.06	0.58	42.57	17.64	N/A	N/A	N/A	N/A	N/A	30.29	0.58	4	Ru/C+H2	10	300	30	10	100	Batch	35	19	N/A	N/A
Sewage sludge	33.1	5.5	5	0.7	25.9	14.1	N/A	N/A	N/A	N/A	N/A	N/A	29.8	600	CRM-N2	5.67	360	60	4	1800	Batch	31	19	N/A	19
Sewage sludge	33.1	5.5	5	0.7	25.9	14.1	N/A	N/A	N/A	N/A	N/A	N/A	29.8	600	RRM500-N2	5.67	360	60	4	1800	Batch	32	18	N/A	18
Sewage sludge	33.1	5.5	5	0.7	25.9	14.1	N/A	N/A	N/A	N/A	N/A	N/A	29.8	600	RRM700-N2	5.67	360	60	4	1800	Batch	27	21	N/A	21
Sewage sludge	33.1	5.5	5	0.7	25.9	14.1	N/A	N/A	N/A	N/A	N/A	N/A	29.8	600	CRM-N2	5.67	360	60	4	1800	Batch	27	28	N/A	17
Sewage sludge	33.1	5.5	5	0.7	25.9	14.1	N/A	N/A	N/A	N/A	N/A	N/A	29.8	600	RRM500-N2	5.67	360	60	4	1800	Batch	32	32	N/A	18
Sewage sludge	33.1	5.5	5	0.7	25.9	14.1	N/A	N/A	N/A	N/A	N/A	N/A	29.8	600	RRM700-N2	5.67	360	60	4	1800	Batch	39	39.5	N/A	15
Cassava Rhizome	39.88	5.39	0.8	8.79	45.14	15.47	N/A	N/A	N/A	N/A	N/A	N/A	8.32	5	K2CO3	4	250	15	N/A	250	Batch	27.49	32.29	N/A	N/A
Cassava Rhizome	39.88	5.39	0.8	8.79	45.14	15.47	N/A	N/A	N/A	N/A	N/A	N/A	8.32	5	K2CO3	4	300	15	N/A	250	Batch	33.7	32.3	N/A	N/A
Penicillin residue	44.88	6.27	5.93	0.77	34.12	18.03	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	Na2CO3		280	180	N/A	N/A	Batch	31	12	N/A	N/A
Penicillin residue	44.88	6.27	5.93	0.77	34.12	18.03	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	Na2CO3		280	180	N/A	N/A	Batch	35	12	N/A	N/A
Penicillin residue	44.88	6.27	5.93	0.77	34.12	18.03	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	Na2CO3		280	180	N/A	N/A	Batch	33	12.5	N/A	N/A
Penicillin residue	44.88	6.27	5.93	0.77	34.12	18.03	N/A	45.4	N/A	N/A	1.66	N/A	8.04	29.2	Na2CO3		280	180	N/A	N/A	Batch	30	12	N/A	N/A
Sugar Cane leaves	44.45	6.26	0.69	0.16	44.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.54	5	Na2CO3	10	250	60	10	100	Batch	6	N/A	N/A	N/A
Sugar Cane leaves	44.45	6.26	0.69	0.16	44.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.54	5	Na2CO3	10	250	60	10	100	Batch	11	N/A	N/A	N/A
Sugar Cane leaves	44.45	6.26	0.69	0.16	44.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.54	5	Na2CO3	10	250	60	10	100	Batch	17.4	N/A	N/A	N/A
Sugar Cane leaves	44.45	6.26	0.69	0.16	44.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.54	5	Na2CO3	10	250	60	10	100	Batch	12.5	N/A	N/A	N/A
Sugar Cane leaves	44.45	6.26	0.69	0.16	44.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.54	5	Na2CO3	10	250	60	10	100	Batch	6	N/A	N/A	N/A
Sugar Cane leaves	44.45	6.26	0.69	0.16	44.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.54	5	Na2CO3	10	300	60	10	100	Batch	22.8	N/A	N/A	N/A
Sugar Cane leaves	44.45	6.26	0.69	0.16	44.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.54	5	Na2CO3	10	300	60	10	100	Batch	28	N/A	N/A	N/A
Sugar Cane leaves	44.45	6.26	0.69	0.16	44.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.54	5	Na2CO3	10	300	60	10	100	Batch	34.8	N/A	N/A	N/A
Sugar Cane leaves	44.45	6.26	0.69	0.16	44.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.54	5	Na2CO3	10	300	60	10	100	Batch	25	N/A	N/A	N/A
Sugar Cane leaves	44.45	6.26	0.69	0.16	44.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.54	5	Na2CO3	10	300	60	10	100	Batch	18	N/A	N/A	N/A
Sugar Cane leaves	44.45	6.26	0.69	0.16	44.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.54	5	Na2CO3	10	350	60	10	100	Batch	9	N/A	N/A	N/A
Sugar Cane leaves	44.45	6.26	0.69	0.16	44.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.54	5	Na2CO3	10	350	60	10	100	Batch	19	N/A	N/A	N/A
Sugar Cane leaves	44.45	6.26	0.69	0.16	44.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.54	5	Na2CO3	10	350	60	10	100	Batch	12	N/A	N/A	N/A
Sugar Cane leaves	44.45	6.26	0.69	0.16	44.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.54	5	Na2CO3	10	350	60	10	100	Batch	27	N/A	N/A	N/A
Sugar Cane leaves	44.45	6.26	0.69	0.16	44.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.54	5	Na2CO3	10	350	60	10	100	Batch	25.4	N/A	N/A	N/A
Debarked teak wood	42.72	6.68	N/A	N/A	50.6	14.95	N/A	N/A	43.43	N/A	N/A	28.09	N/A	15	Mg(ClO4)2	2	300	30	N/A	N/A	Batch	7	41	N/A	N/A
Debarked teak wood	42.72	6.68	N/A	N/A	50.6	14.95	N/A	N/A	43.43	N/A	N/A	28.09	N/A	16	Mg(ClO4)2	5	300	30	N/A	N/A	Batch	5	45	N/A	N/A
Debarked teak wood	42.72	6.68	N/A	N/A	50.6	14.95	N/A	N/A	43.43	N/A	N/A	28.09	N/A	17	Mg(ClO4)2	10	300	30	N/A	N/A	Batch	3	47	N/A	N/A
Debarked teak wood	42.72	6.68	N/A	N/A	50.6	14.95	N/A	N/A	43.43	N/A	N/A	28.09	N/A	18	HcClO4	2	300	30	N/A	N/A	Batch	7	47	N/A	N/A
Debarked teak wood	42.72	6.68	N/A	N/A	50.6	14.95	N/A	N/A	43.43	N/A	N/A	28.09	N/A	19	HcClO4	5	300	30	N/A	N/A	Batch	6	43	N/A	N/A
Debarked teak wood	42.72	6.68	N/A	N/A	50.6	14.95	N/A	N/A	43.43	N/A	N/A	28.09	N/A	20	HcClO4	10	300	30	N/A	N/A	Batch	5	44	N/A	N/A

Debarked teak wood	42.72	6.68	N/A	N/A	50.6	14.95	N/A	N/A	43.43	N/A	N/A	28.09	N/A	21	Mf(ClO4)2/HClO4(2/10)	12	300	30	N/A	N/A	Batch	4	43	N/A	N/A
Debarked teak wood	42.72	6.68	N/A	N/A	50.6	14.95	N/A	N/A	43.43	N/A	N/A	28.09	N/A	22	Mf(ClO4)2/HClO4(5/5)	10	300	30	N/A	N/A	Batch	3	46	N/A	N/A
Debarked teak wood	42.72	6.68	N/A	N/A	50.6	14.95	N/A	N/A	43.43	N/A	N/A	28.09	N/A	23	Mf(ClO4)2/HClO4(10/2)	12	300	30	N/A	N/A	Batch	3.5	51	N/A	N/A
Potato starch	40.23	6.41	0.05	0	53.31	13.24	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4	SC	5	300	60	N/A	500	Batch	31	8.8	N/A	N/A
Potato starch	40.23	6.41	0.05	0	53.31	13.24	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4	MSC	5	300	60	N/A	500	Batch	34.5	11.1	N/A	N/A
Potato starch	40.23	6.41	0.05	0	53.31	13.24	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4	DSC	5	300	60	N/A	500	Batch	34	2.1	N/A	N/A
Potato starch	40.23	6.41	0.05	0	53.31	13.24	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4	KSC	5	300	60	N/A	500	Batch	36.6	14	N/A	N/A
Potato starch	40.23	6.41	0.05	0	53.31	13.24	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4	SSC	5	300	60	N/A	500	Batch	35.5	13.8	N/A	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	ZnFe2O4	N/A	N/A	N/A	N/A	300	Batch	17.01	37	45.99	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	ZnFe2O4+NaOH	N/A	N/A	N/A	N/A	300	Batch	31	18	51	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	NiFe2O4	N/A	N/A	N/A	N/A	300	Batch	19	33	48	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	NiFe2O4+NaOH	N/A	N/A	N/A	N/A	300	Batch	24	15	61	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	CoFe2O4	N/A	N/A	N/A	N/A	300	Batch	17.2	35	47.8	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	CoFe2O4+NaOH	N/A	N/A	N/A	N/A	300	Batch	20.5	19	60.5	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	NaOH	N/A	N/A	N/A	N/A	300	Batch	21	16	63	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	ZnFe2O4	N/A	180	N/A	N/A	N/A	Batch	9.22	45.19	45.59	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	ZnFe2O4	N/A	200	N/A	N/A	N/A	Batch	14.5	41.46	44.05	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	ZnFe2O4	N/A	220	N/A	N/A	N/A	Batch	17.01	36.19	46.8	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	ZnFe2O4	N/A	240	N/A	N/A	N/A	Batch	20.55	24.48	54.97	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	ZnFe2O4	N/A	260	N/A	N/A	N/A	Batch	24.17	17.26	58.56	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	ZnFe2O4+NaOH	N/A	180	N/A	N/A	N/A	Batch	34.02	30.26	35.72	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	ZnFe2O4+NaOH	N/A	200	N/A	N/A	N/A	Batch	37.65	25.05	37.3	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	ZnFe2O4+NaOH	N/A	220	N/A	N/A	N/A	Batch	31.28	17.59	51.13	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	ZnFe2O4+NaOH	N/A	240	N/A	N/A	N/A	Batch	28.04	10.98	60.98	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	ZnFe2O4+NaOH	N/A	260	N/A	N/A	N/A	Batch	23.88	5.25	70.88	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	NiFe2O4	N/A	180	N/A	N/A	N/A	Batch	16.54	39.74	43.72	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	NiFe2O4	N/A	200	N/A	N/A	N/A	Batch	17	37.04	45.96	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	NiFe2O4	N/A	220	N/A	N/A	N/A	Batch	19.39	33.44	47.17	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	NiFe2O4	N/A	240	N/A	N/A	N/A	Batch	22.59	21.59	55.82	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	NiFe2O4	N/A	260	N/A	N/A	N/A	Batch	26.45	15.74	57.81	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	NiFe2O4+NaOH	N/A	180	N/A	N/A	N/A	Batch	24.21	29.21	46.57	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	NiFe2O4+NaOH	N/A	200	N/A	N/A	N/A	Batch	23.65	21.75	54.61	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	NiFe2O4+NaOH	N/A	220	N/A	N/A	N/A	Batch	24.43	15.44	60.13	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	NiFe2O4+NaOH	N/A	240	N/A	N/A	N/A	Batch	23.99	11.1	64.91	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	NiFe2O4+NaOH	N/A	260	N/A	N/A	N/A	Batch	27.05	7.75	65.19	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	CoFe2O4	N/A	180	N/A	N/A	N/A	Batch	14.45	40.54	45.01	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	CoFe2O4	N/A	200	N/A	N/A	N/A	Batch	15.49	40.92	43.59	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	CoFe2O4	N/A	220	N/A	N/A	N/A	Batch	17.2	34.55	48.25	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	CoFe2O4	N/A	240	N/A	N/A	N/A	Batch	20.44	22.28	57.28	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	CoFe2O4	N/A	260	N/A	N/A	N/A	Batch	24.49	16.83	58.68	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	CoFe2O4+NaOH	N/A	180	N/A	N/A	N/A	Batch	32.01	30.74	37.25	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	CoFe2O4+NaOH	N/A	200	N/A	N/A	N/A	Batch	26.87	26.26	46.87	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	CoFe2O4+NaOH	N/A	220	N/A	N/A	N/A	Batch	20.49	19.3	60.21	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	CoFe2O4+NaOH	N/A	240	N/A	N/A	N/A	Batch	20.05	14.77	65.18	N/A
Corn straw	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.82	25.37	N/A	19.85	6.53	10	CoFe2O4+NaOH	N/A	260	N/A	N/A	N/A	Batch	17.02	10.41	72.58	N/A
Antibiotic residue	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18	HZSM-5	10	280	150	N/A	250	Batch	32.5	9	31.5	27
Antibiotic residue	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	HZSM-5	15	280	150	N/A	250	Batch	33.74	7.26	28	31
Antibiotic residue	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	HZSM-5	20	280	150	N/A	250	Batch	33	7	26	34
Antibiotic residue	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	MCM-41	10	280	150	N/A	250	Batch	32.5	9	31	27.5
Antibiotic residue	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	MCM-41	15	280	150	N/A	250	Batch	33.38	6.62	28	32

Antibiotic residue	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	MCM-41	20	280	150	N/A	250	Batch	32.6	5.9	28.5	33
Antibiotic residue	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	y-Al2O3	10	280	150	N/A	250	Batch	32	7	30.5	30.5
Antibiotic residue	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	y-Al2O3	15	280	150	N/A	250	Batch	32.48	7.02	28.5	32
Antibiotic residue	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	y-Al2O3	20	280	150	N/A	250	Batch	32.4	7.2	26.4	34
Trentepohlia Gravity	41.55	5.25	2.15	0.35	50.7	N/A	8.4	27.9	N/A	N/A	9.95	N/A	N/A	2	ZSM-5	5	325	60	N/A	100	Batch	39.7	33	N/A	7.3
Trentepohlia Gravity	41.55	5.25	2.15	0.35	50.7	N/A	8.4	27.9	N/A	N/A	9.95	N/A	N/A	2	ZSM-5	7	325	60	N/A	100	Batch	34.2	26	N/A	13.8
Trentepohlia Gravity	41.55	5.25	2.15	0.35	50.7	N/A	8.4	27.9	N/A	N/A	9.95	N/A	N/A	2	MCM-41	5	325	60	N/A	100	Batch	28.4	24.5	N/A	32.1
Trentepohlia Gravity	41.55	5.25	2.15	0.35	50.7	N/A	8.4	27.9	N/A	N/A	9.95	N/A	N/A	2	MCM-41	7	325	60	N/A	100	Batch	26.3	24.5	N/A	29.7
Chlorella	51.34	7.29	9.35	0.57	31.45	23.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.5	ZY-air	5	240	0	6	N/A	Batch	44.63	N/A	N/A	N/A
Chlorella	51.34	7.29	9.35	0.57	31.45	23.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.5	ZyY-H2	5	240	0	6	N/A	Batch	46.83	N/A	N/A	N/A
Chlorella	51.34	7.29	9.35	0.57	31.45	23.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.5	ZY-AP-H2	5	240	0	6	N/A	Batch	47.96	N/A	N/A	N/A
Chlorella	51.34	7.29	9.35	0.57	31.45	23.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.5	ZY-HP-H2	5	240	0	6	N/A	Batch	50.04	N/A	N/A	N/A
Chlorella	51.34	7.29	9.35	0.57	31.45	23.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.5	ZY-air	5	240	15	6	N/A	Batch	49.7	N/A	N/A	N/A
Chlorella	51.34	7.29	9.35	0.57	31.45	23.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.5	ZY-H2	5	240	15	6	N/A	Batch	51.2	N/A	N/A	N/A
Chlorella	51.34	7.29	9.35	0.57	31.45	23.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.5	ZY-AP-H2	5	240	15	6	N/A	Batch	49.74	N/A	N/A	N/A
Chlorella	51.34	7.29	9.35	0.57	31.45	23.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.5	ZY-HP-H2	5	240	15	6	N/A	Batch	51.78	N/A	N/A	N/A
Chlorella	51.34	7.29	9.35	0.57	31.45	23.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.5	ZY-air	5	250	0	6	N/A	Batch	48.5	N/A	N/A	N/A
Chlorella	51.34	7.29	9.35	0.57	31.45	23.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.5	ZY-H2	5	250	0	6	N/A	Batch	50.24	N/A	N/A	N/A
Chlorella	51.34	7.29	9.35	0.57	31.45	23.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.5	ZY-AP-H2	5	250	0	6	N/A	Batch	49.28	N/A	N/A	N/A
Chlorella	51.34	7.29	9.35	0.57	31.45	23.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.5	ZY-HP-H2	5	250	0	6	N/A	Batch	53.01	N/A	N/A	N/A
Chlorella	51.34	7.29	9.35	0.57	31.45	23.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.5	ZY-air	5	250	15	6	N/A	Batch	50.3	N/A	N/A	N/A
Chlorella	51.34	7.29	9.35	0.57	31.45	23.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.5	ZY-H2	5	250	15	6	N/A	Batch	50.28	N/A	N/A	N/A
Chlorella	51.34	7.29	9.35	0.57	31.45	23.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.5	ZY-AP-H2	5	250	15	6	N/A	Batch	52.26	N/A	N/A	N/A
Chlorella	51.34	7.29	9.35	0.57	31.45	23.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.5	ZY-HP-H2	5	250	15	6	N/A	Batch	51.46	N/A	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	K2CO3	5	350	15	N/A	15	Batch	27.4	7	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	K2CO3	10	350	15	N/A	15	Batch	26.5	6	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	K2CO3	15	350	15	N/A	15	Batch	27	5.5	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	Al2O3	5	350	15	N/A	15	Batch	26	7	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	Al2O3	10	350	15	N/A	15	Batch	27.74	6.5	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	Al2O3	15	350	15	N/A	15	Batch	26	7	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	ATP	5	350	15	N/A	15	Batch	26	9	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	ATP	10	350	15	N/A	15	Batch	26.24	10	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	ATP	15	350	15	N/A	15	Batch	26	11	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	Co-Al2O3	5	350	15	N/A	15	Batch	27	9	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	Co-Al2O3	10	350	15	N/A	15	Batch	28.31	6	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	Co-Al2O3	15	350	15	N/A	15	Batch	27.5	9	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	Co-ATP	5	350	15	N/A	15	Batch	29	5.5	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	Co-ATP	10	350	15	N/A	15	Batch	29.03	4	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	Co-ATP	15	350	15	N/A	15	Batch	28.5	5.8	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	Co-Mo/Al2O3	5	350	15	N/A	15	Batch	28	7	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	Co-Mo/Al2O3	10	350	15	N/A	15	Batch	28.93	6.8	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	Co-Mo/Al2O3	15	350	15	N/A	15	Batch	28	6.5	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	Co-Mo/ATP	5	350	15	N/A	15	Batch	30	5	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	Co-Mo/ATP	10	350	15	N/A	15	Batch	31.5	2.5	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	Co-Mo/ATP	15	350	15	N/A	15	Batch	31	4.8	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	K2CO3+Co/Al2O3	10	350	15	N/A	15	Batch	27.5	6	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	K2CO3+Co-Mo/Al2O3	10	350	15	N/A	15	Batch	27	4	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	K2CO3+CO/ATP	5	350	15	N/A	15	Batch	27.5	5	N/A	N/A
Sewage sludge	25.16	5.04	4.6	0	65.2	N/A	23.58	40.35	N/A	N/A	23.6	12.47	44.01	1.35	J2CO3+Co_Mo/ATP	10	350	15	N/A	15	Batch	27	6	N/A	N/A
Woodchips	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NiMo	1	320	240	N/A	1000	Batch	21.52	9.11	63.21	6.16

Woodchips	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NiMo-10	1	320	240	N/A	1000	Batch	13.32	6.43	68.11	12.14
Woodchips	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NiMo-15	1	320	240	N/A	1000	Batch	15.57	5.19	63.75	15.49
Woodchips	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NiMo-20	1	320	240	N/A	1000	Batch	13.32	2.66	65.44	18.57
Scenedesmus obliquus (CM)	43.25	8.46	6.83	0.63	40.83	19.47	17.16	42.35	N/A	N/A	25.36	N/A	10.17	2	Zr-HZSM-5	20	250	N/A	N/A	50	Batch	13	63	N/A	N/A
Scenedesmus obliquus (NSM)	45.03	7.5	3.59	0.98	42.9	18.37	21.62	22.08	N/A	N/A	42.55	N/A	10.17	2	Zr-HZSM-5	20	250	N/A	N/A	50	Batch	15	58	N/A	N/A
Scenedesmus obliquus (CM)	43.25	8.46	6.83	0.63	40.83	19.47	17.16	42.35	N/A	N/A	25.36	N/A	10.17	2	Zr-HZSM-5	20	300	N/A	N/A	50	Batch	15	42	N/A	N/A
Scenedesmus obliquus (NSM)	45.03	7.5	3.59	0.98	42.9	18.37	21.62	22.08	N/A	N/A	42.55	N/A	10.17	2	Zr-HZSM-5	20	300	N/A	N/A	50	Batch	24	30	N/A	N/A
Scenedesmus obliquus (CM)	43.25	8.46	6.83	0.63	40.83	19.47	17.16	42.35	N/A	N/A	25.36	N/A	10.17	2	Zr-HZSM-5	20	350	N/A	N/A	50	Batch	24.27	27	N/A	N/A
Scenedesmus obliquus (NSM)	45.03	7.5	3.59	0.98	42.9	18.37	21.62	22.08	N/A	N/A	42.55	N/A	10.17	2	Zr-HZSM-5	20	350	N/A	N/A	50	Batch	52.8	15	N/A	N/A
Scenedesmus obliquus (NSM)	45.03	7.5	3.59	0.98	42.9	18.37	21.62	22.08	N/A	N/A	42.55	N/A	10.17	2	Zr-HZSM-6	10	350	N/A	N/A	50	Batch	43	18	N/A	N/A
Scenedesmus obliquus (NSM)	45.03	7.5	3.59	0.98	42.9	18.37	21.62	22.08	N/A	N/A	42.55	N/A	10.17	2	Zr-HZSM-6	20	350	N/A	N/A	50	Batch	52	16	N/A	N/A
Scenedesmus obliquus (NSM)	45.03	7.5	3.59	0.98	42.9	18.37	21.62	22.08	N/A	N/A	42.55	N/A	10.17	2	Zr-HZSM-6	30	350	N/A	N/A	50	Batch	52.5	15.5	N/A	N/A
Scenedesmus obliquus (NSM)	45.03	7.5	3.59	0.98	42.9	18.37	21.62	22.08	N/A	N/A	42.55	N/A	10.17	2	Zr-HZSM-6	40	350	N/A	N/A	50	Batch	52	14.5	N/A	N/A
Chlorella Sp	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/Al2O3	5	N/A	N/A	N/A	300	Batch	N/A	N/A	N/A	N/A
Chlorella Sp	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/Al2O3	15	N/A	N/A	N/A	300	Batch	N/A	N/A	N/A	N/A
Chlorella Sp	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/Al2O3	5	N/A	N/A	N/A	300	Batch	N/A	N/A	N/A	N/A
Chlorella Sp	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/Al2O3	15	N/A	N/A	N/A	300	Batch	N/A	N/A	N/A	N/A
Chlorella Sp	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/Al2O3	2.93	N/A	N/A	N/A	300	Batch	N/A	N/A	N/A	N/A
Chlorella Sp	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/Al2O3	17.07	N/A	N/A	N/A	300	Batch	N/A	N/A	N/A	N/A
Chlorella Sp	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/Al2O3	10	N/A	N/A	N/A	300	Batch	N/A	N/A	N/A	N/A
Chlorella Sp	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/Al2O3	10	N/A	N/A	N/A	300	Batch	N/A	N/A	N/A	N/A
Chlorella Sp	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/Al2O3	10	N/A	N/A	N/A	300	Batch	N/A	N/A	N/A	N/A
Chlorella Sp	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/Al2O3	10	N/A	N/A	N/A	300	Batch	N/A	N/A	N/A	N/A
Chlorella Sp	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/Al2O3	10	N/A	N/A	N/A	300	Batch	N/A	N/A	N/A	N/A
Chlorella Sp	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/Al2O3	10	N/A	N/A	N/A	300	Batch	N/A	N/A	N/A	N/A
Tetra Pak	50.55	6.226	N/A	N/A	38.07	10.18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20	Ni:Ce (10:0)	N/A	360	30	30	316000	Batch	16.5	31	N/A	N/A
Tetra Pak	50.55	6.226	N/A	N/A	38.07	10.18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20	Ni:Ce (10:1)	N/A	360	30	30	316000	Batch	17.5	31	N/A	N/A
Tetra Pak	50.55	6.226	N/A	N/A	38.07	10.18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20	Ni:Ce (10:3)	N/A	360	30	30	316000	Batch	19	32	N/A	N/A
Tetra Pak	50.55	6.226	N/A	N/A	38.07	10.18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20	Ni:Ce (10:5)	N/A	360	30	30	316000	Batch	22	30.5	N/A	N/A
Tetra Pak	50.55	6.226	N/A	N/A	38.07	10.18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20	Ni:Ce (10:7)	N/A	360	30	30	316000	Batch	17.5	31.5	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	CHZSM5	6	250	30	N/A	100	Batch	9.2	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1Ni1	6	250	30	N/A	100	Batch	17.8	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1Ni2	6	250	30	N/A	100	Batch	13.2	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba2Ni1	6	250	30	N/A	100	Batch	18.2	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1La1	6	250	30	N/A	100	Batch	13.2	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1La2	6	250	30	N/A	100	Batch	19.3	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba2La1	6	250	30	N/A	100	Batch	18.5	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1Ce1	6	250	30	N/A	100	Batch	15.5	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1Ce2	6	250	30	N/A	100	Batch	13.5	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba2Ce1	6	250	30	N/A	100	Batch	15.2	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1La2/CHZSM5	6	160	30	N/A	100	Batch	9.5	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1La2/CHZSM5	6	190	30	N/A	100	Batch	15	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1La2/CHZSM5	6	220	30	N/A	100	Batch	12	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1La2/CHZSM5	6	250	30	N/A	100	Batch	19.3	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1La2/CHZSM5	6	280	30	N/A	100	Batch	16	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1La2/CHZSM	6	250	15	N/A	100	Batch	12	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1La2/CHZSM	6	250	30	N/A	100	Batch	19.5	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1La2/CHZSM	6	250	60	N/A	100	Batch	18	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1La2/CHZSM	3	250	30	N/A	100	Batch	10	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1La2/CHZSM	6	250	30	N/A	100	Batch	19.5	N/A	N/A	N/A

Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1La2/CHZSM	9	250	30	N/A	100	Batch	16	N/A	N/A	N/A
Empty fruit bunch	45.44	6.22	1.58	0.36	46.4	N/A	N/A	N/A	30.07	41.32	N/A	26.82	2.42	5	Ba1La2/CHZSM	12	250	30	N/A	100	Batch	14	N/A	N/A	N/A
Sewage sludge	44.4	5.35	6.3	1.35	42.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	K2CO3	5	320	15	N/A	50	Batch	28	12.5	41	18.5
Sewage sludge	44.4	5.35	6.3	1.35	42.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	K2CO3	10	320	15	N/A	50	Batch	25	12	43	21
Sewage sludge	44.4	5.35	6.3	1.35	42.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	K2CO3	15	320	15	N/A	50	Batch	26	10.5	42.5	23
Sewage sludge	44.4	5.35	6.3	1.35	42.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Al2O3	10	320	15	N/A	50	Batch	17.5	17	53.5	12.5
Sewage sludge	44.4	5.35	6.3	1.35	42.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Co-Mo/Al2O3	10	320	15	N/A	50	Batch	27.5	17.7	38	15
Sewage sludge	44.4	5.35	6.3	1.35	42.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	K2CO3-Co-Mo/Atp	10	320	15	N/A	50	Batch	22	12.5	47	17.5
Sewage sludge	44.4	5.35	6.3	1.35	42.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	ATP	10	320	15	N/A	50	Batch	22.5	14	52.5	10
Sewage sludge	44.4	5.35	6.3	1.35	42.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Co/ATP	10	320	15	N/A	50	Batch	24.5	12.5	40	12.5
Sewage sludge	44.4	5.35	6.3	1.35	42.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Mo/ATP	10	320	15	N/A	50	Batch	25.5	14	47.5	14
Sewage sludge	44.4	5.35	6.3	1.35	42.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Co-Mo/ATP	10	320	15	N/A	50	Batch	34.5	10	41	15
Food waste	49.3	7.3	5.8	0.1	37.4	22.5	N/A	N/A	N/A	N/A	N/A	N/A	3.2	130	Fe-Co2	4.6	350	60	N/A	250	Batch	39.13	N/A	N/A	N/A
Food waste	49.3	7.3	5.8	0.1	37.4	22.5	N/A	N/A	N/A	N/A	N/A	N/A	3.2	130	Fe-H2	4.6	350	60	N/A	250	Batch	51.99	N/A	N/A	N/A
Food waste	49.3	7.3	5.8	0.1	37.4	22.5	N/A	N/A	N/A	N/A	N/A	N/A	3.2	130	NiMo/Al2O3-CO2	3	350	60	N/A	250	Batch	33.3	N/A	N/A	N/A
Food waste	49.3	7.3	5.8	0.1	37.4	22.5	N/A	N/A	N/A	N/A	N/A	N/A	3.2	130	NiMo/Al2O3H2	3	350	60	N/A	250	Batch	58.15	N/A	N/A	N/A
Food waste	49.3	7.3	5.8	0.1	37.4	22.5	N/A	N/A	N/A	N/A	N/A	N/A	3.2	130	Ru/Al2O3-CO2	3	350	60	N/A	250	Batch	38.23	N/A	N/A	N/A
Food waste	49.3	7.3	5.8	0.1	37.4	22.5	N/A	N/A	N/A	N/A	N/A	N/A	3.2	130	Pd/Al2O3-CO2	3	350	60	N/A	250	Batch	32.58	N/A	N/A	N/A
Food waste	49.3	7.3	5.8	0.1	37.4	22.5	N/A	N/A	N/A	N/A	N/A	N/A	3.2	130	Pt/Al2O3-CO2	1.5	350	60	N/A	250	Batch	35.64	N/A	N/A	N/A
Scenedesmus sp	49.08	7.1	9.1	0.99	33.5	22.99	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20	NaOH-N2	2	200	60	N/A	N/A	Batch	32.8	N/A	N/A	N/A
Scenedesmus sp	49.08	7.1	9.1	0.99	33.5	22.99	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20	NaOH-H2	2	200	60	N/A	N/A	Batch	38.6	N/A	N/A	N/A
Scenedesmus sp	49.08	7.1	9.1	0.99	33.5	22.99	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20	K2CO3-N2	2	200	60	N/A	N/A	Batch	31.5	N/A	N/A	N/A
Scenedesmus sp	49.08	7.1	9.1	0.99	33.5	22.99	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20	K2CO3-H2	2	200	60	N/A	N/A	Batch	35.9	N/A	N/A	N/A
Scenedesmus sp	49.08	7.1	9.1	0.99	33.5	22.99	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20	Ru/C-N2	2	200	60	N/A	N/A	Batch	38.65	N/A	N/A	N/A
Scenedesmus sp	49.08	7.1	9.1	0.99	33.5	22.99	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20	Ru/C-H2	2	200	60	N/A	N/A	Batch	43.5	N/A	N/A	N/A
Scenedesmus sp	49.08	7.1	9.1	0.99	33.5	22.99	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20	MoS2-N2	2	200	60	N/A	N/A	Batch	35.5	N/A	N/A	N/A
Scenedesmus sp	49.08	7.1	9.1	0.99	33.5	22.99	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20	MoS2-H2	2	200	60	N/A	N/A	Batch	41.9	N/A	N/A	N/A
Scenedesmus sp	49.08	7.1	9.1	0.99	33.5	22.99	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20	Pt/C-N2	2	200	60	N/A	N/A	Batch	42.3	N/A	N/A	N/A
Scenedesmus sp	49.08	7.1	9.1	0.99	33.5	22.99	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20	Pt/C-H2	2	200	60	N/A	N/A	Batch	49.5	N/A	N/A	N/A
Chlorella	50.72	6.89	10.11	0.95	31.33	22.31	4	56	N/A	N/A	35	N/A	5	0.45	Ru/C-Formic acid		300	60	50	4	Batch	28	N/A	N/A	N/A
Chlorella	50.72	6.89	10.11	0.95	31.33	22.31	4	56	N/A	N/A	35	N/A	5	0.45	Au/C3N4 - formic acid		300	60	50	4	Batch	26	N/A	N/A	N/A
Potato starch	37	5.42	0.08	0	57.49	13.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.4	Pd/C	5	320	30	N/A	4	Batch	21.8	25	N/A	N/A
Potato starch	37	5.42	0.08	0	57.49	13.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/C	15	320	30	N/A	4	Batch	20.6	9	N/A	N/A
Potato starch	37	5.42	0.08	0	57.49	13.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/C	25	320	30	N/A	4	Batch	18.8	10.4	N/A	N/A
Potato starch	37	5.42	0.08	0	57.49	13.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Co-Mo/γ-Al2O3	5	320	30	N/A	4	Batch	24.8	10.4	N/A	N/A
Potato starch	37	5.42	0.08	0	57.49	13.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Co-Mo/γ-Al2O4	15	320	30	N/A	4	Batch	22.5	8.1	N/A	N/A
Potato starch	37	5.42	0.08	0	57.49	13.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Co-Mo/γ-Al2O5	25	320	30	N/A	4	Batch	22.7	7.9	N/A	N/A
Potato starch	37	5.42	0.08	0	57.49	13.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Zeolite	5	320	30	N/A	4	Batch	15.4	20.9	N/A	N/A
Potato starch	37	5.42	0.08	0	57.49	13.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Zeolite	15	320	30	N/A	4	Batch	11.8	18.9	N/A	N/A
Potato starch	37	5.42	0.08	0	57.49	13.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Zeolite	25	320	30	N/A	4	Batch	10.2	17.4	N/A	N/A
Cellulose	41.9	5.07	0.12	0.23	52.91	15.13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/C	5	320	30	N/A	4	Batch	12.6	28.1	N/A	N/A
Cellulose	41.9	5.07	0.12	0.23	52.91	15.13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/C	15	320	30	N/A	4	Batch	16.2	14.8	N/A	N/A
Cellulose	41.9	5.07	0.12	0.23	52.91	15.13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/C	25	320	30	N/A	4	Batch	7.3	19.8	N/A	N/A
Cellulose	41.9	5.07	0.12	0.23	52.91	15.13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Co-Mo/γ-Al2O3	5	320	30	N/A	4	Batch	23.3	16.5	N/A	N/A
Cellulose	41.9	5.07	0.12	0.23	52.91	15.13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Co-Mo/γ-Al2O4	15	320	30	N/A	4	Batch	21.5	15.9	N/A	N/A
Cellulose	41.9	5.07	0.12	0.23	52.91	15.13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Co-Mo/γ-Al2O5	25	320	30	N/A	4	Batch	11.8	23.5	N/A	N/A
Cellulose	41.9	5.07	0.12	0.23	52.91	15.13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Zeolite	5	320	30	N/A	4	Batch	7.7	38	N/A	N/A
Cellulose	41.9	5.07	0.12	0.23	52.91	15.13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Zeolite	15	320	30	N/A	4	Batch	6.6	30.2	N/A	N/A
Cellulose	41.9	5.07	0.12	0.23	52.91	15.13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Zeolite	25	320	30	N/A	4	Batch	6	29.1	N/A	N/A
Pectin	36.3	4.44	0.47	0.13	58.6	11.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/C	5	320	30	N/A	4	Batch	7.1	22	N/A	N/A

Pectin	36.3	4.44	0.47	0.13	58.6	11.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/C	15	320	30	N/A	4	Batch	9.2	16.8	N/A	N/A
Pectin	36.3	4.44	0.47	0.13	58.6	11.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/C	25	320	30	N/A	4	Batch	9.5	17.6	N/A	N/A
Pectin	36.3	4.44	0.47	0.13	58.6	11.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Co-Mo/γ-Al2O3	5	320	30	N/A	4	Batch	8	23.1	N/A	N/A
Pectin	36.3	4.44	0.47	0.13	58.6	11.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Co-Mo/γ-Al2O3	15	320	30	N/A	4	Batch	6.7	18.6	N/A	N/A
Pectin	36.3	4.44	0.47	0.13	58.6	11.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Co-Mo/γ-Al2O3	25	320	30	N/A	4	Batch	11.9	15.2	N/A	N/A
Pectin	36.3	4.44	0.47	0.13	58.6	11.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Zeolite	5	320	30	N/A	4	Batch	7.7	21.7	N/A	N/A
Pectin	36.3	4.44	0.47	0.13	58.6	11.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Zeolite	15	320	30	N/A	4	Batch	6.3	21.8	N/A	N/A
Pectin	36.3	4.44	0.47	0.13	58.6	11.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Zeolite	25	320	30	N/A	4	Batch	8.7	15.8	N/A	N/A
Chitin	43.3	5.27	6.39	0.16	44.9	16.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/C	5	320	30	N/A	4	Batch	9.1	26.7	N/A	N/A
Chitin	43.3	5.27	6.39	0.16	44.9	16.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/C	15	320	30	N/A	4	Batch	8.4	26.1	N/A	N/A
Chitin	43.3	5.27	6.39	0.16	44.9	16.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Pd/C	25	320	30	N/A	4	Batch	4.7	21.9	N/A	N/A
Chitin	43.3	5.27	6.39	0.16	44.9	16.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Co-Mo/γ-Al2O3	5	320	30	N/A	4	Batch	9.5	29.7	N/A	N/A
Chitin	43.3	5.27	6.39	0.16	44.9	16.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Co-Mo/γ-Al2O3	15	320	30	N/A	4	Batch	8.1	28.5	N/A	N/A
Chitin	43.3	5.27	6.39	0.16	44.9	16.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Co-Mo/γ-Al2O3	25	320	30	N/A	4	Batch	13.2	24	N/A	N/A
Chitin	43.3	5.27	6.39	0.16	44.9	16.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Zeolite	5	320	30	N/A	4	Batch	8.3	32.5	N/A	N/A
Chitin	43.3	5.27	6.39	0.16	44.9	16.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Zeolite	15	320	30	N/A	4	Batch	7.4	29.9	N/A	N/A
Chitin	43.3	5.27	6.39	0.16	44.9	16.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Zeolite	25	320	30	N/A	4	Batch	11.9	22.8	N/A	N/A
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4-W(10g)	5	N/A	N/A	N/A	N/A	Batch	28.5	46	N/A	27
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4-W(10g)	10	N/A	N/A	N/A	N/A	Batch	35.8	40	N/A	26
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4-W(10g)	15	N/A	N/A	N/A	N/A	Batch	34.6	37	N/A	30
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4-W(10g)	20	N/A	N/A	N/A	N/A	Batch	34.1	36.5	N/A	32
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4-E(10g)	5	N/A	N/A	N/A	N/A	Batch	67	17.8	N/A	17.8
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4-E(10g)	10	N/A	N/A	N/A	N/A	Batch	68	17.5	N/A	17.5
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4-E(10g)	15	N/A	N/A	N/A	N/A	Batch	71.8	15.5	N/A	15.2
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4-E(10g)	20	N/A	N/A	N/A	N/A	Batch	70	14.5	N/A	14.8
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4-M(10g)	5	N/A	N/A	N/A	N/A	Batch	65.5	22.5	N/A	14.8
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4-M(10g)	10	N/A	N/A	N/A	N/A	Batch	67.5	20.5	N/A	15
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4-M(10g)	15	N/A	N/A	N/A	N/A	Batch	68.6	20	N/A	15
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4-M(10g)	20	N/A	N/A	N/A	N/A	Batch	67.5	21	N/A	16
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4	15	250	N/A	N/A	N/A	Batch	72.5	22.5	N/A	5
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4	15	280	N/A	N/A	N/A	Batch	89	5	N/A	15
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4	15	310	N/A	N/A	N/A	Batch	79	4	N/A	20
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4	N/A	N/A	15	N/A	N/A	Batch	77	7.5	N/A	17
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4	N/A	N/A	30	N/A	N/A	Batch	74	5	N/A	14.5
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4	N/A	N/A	60	N/A	N/A	Batch	80	12.5	N/A	14
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4	10	N/A	N/A	N/A	N/A	Batch	77.5	12.5	N/A	12.5
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4	20	N/A	N/A	N/A	N/A	Batch	84	5	N/A	15
Alkali lignin	60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	Ni/MgAl2O4	30	N/A	N/A	N/A	N/A	Batch	82	6	N/A	22.5
Enteromorpha prolifera	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	220	10	N/A	N/A	Batch	7	24	N/A	N/A
Enteromorpha prolifera	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	240	10	N/A	N/A	Batch	8	20	N/A	N/A
Enteromorpha prolifera	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	260	10	N/A	N/A	Batch	15	13	N/A	N/A
Enteromorpha prolifera	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	280	10	N/A	N/A	Batch	17	14	N/A	N/A
Enteromorpha prolifera	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	300	10	N/A	N/A	Batch	11	16	N/A	N/A
Enteromorpha prolifera	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	1	N/A	10	N/A	N/A	Batch	15.5	12.5	N/A	N/A
Enteromorpha prolifera	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	3	N/A	10	N/A	N/A	Batch	15	12	N/A	N/A
Enteromorpha prolifera	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	4	N/A	10	N/A	N/A	Batch	15	11.5	N/A	N/A
Enteromorpha prolifera	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	5	N/A	10	N/A	N/A	Batch	15.2	14.8	N/A	N/A
Chlorella vulgaris	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	9	N/A	10	N/A	N/A	Batch	15	14.9	N/A	N/A
Chlorella vulgaris	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	220	10	N/A	N/A	Batch	13	11	N/A	N/A
Chlorella vulgaris	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	240	10	N/A	N/A	Batch	17.5	12.5	N/A	N/A

Chlorella vulgaris	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	260	10	N/A	N/A	Batch	20	9	N/A	N/A
Chlorella vulgaris	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	280	10	N/A	N/A	Batch	25	8	N/A	N/A
Chlorella vulgaris	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	300	10	N/A	N/A	Batch	25	12	N/A	N/A
Chlorella vulgaris	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	1	N/A	10	N/A	N/A	Batch	28	3	N/A	N/A
Chlorella vulgaris	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	3	N/A	10	N/A	N/A	Batch	27.5	3	N/A	N/A
Chlorella vulgaris	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	4	N/A	10	N/A	N/A	Batch	26	4	N/A	N/A
Chlorella vulgaris	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	5	N/A	10	N/A	N/A	Batch	30	2	N/A	N/A
Chlorella vulgaris	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	9	N/A	10	N/A	N/A	Batch	28	2	N/A	N/A
Polysaccharides	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	180	10	N/A	N/A	Batch	1	1	N/A	N/A
Polysaccharides	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	200	10	N/A	N/A	Batch	6	9	N/A	N/A
Polysaccharides	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	220	10	N/A	N/A	Batch	5	12	N/A	N/A
Polysaccharides	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	240	10	N/A	N/A	Batch	3	26	N/A	N/A
Polysaccharides	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	260	10	N/A	N/A	Batch	2	28	N/A	N/A
Polysaccharides	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	280	10	N/A	N/A	Batch	2	27.5	N/A	N/A
Protein	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	200	10	N/A	N/A	Batch	2	18	N/A	N/A
Protein	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	220	10	N/A	N/A	Batch	3	15	N/A	N/A
Protein	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	240	10	N/A	N/A	Batch	5	15.5	N/A	N/A
Protein	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	260	10	N/A	N/A	Batch	6	14	N/A	N/A
Protein	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	280	10	N/A	N/A	Batch	8	12	N/A	N/A
Protein	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	N/A	300	10	N/A	N/A	Batch	12	11	N/A	N/A
Polysacchrides	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	1	N/A	10	N/A	N/A	Batch	7	13	N/A	N/A
Polysacchrides	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	So420/ZrO2	3	N/A	10	N/A	N/A	Batch	6.8	12.2	N/A	N/A
Polysacchrides	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	N/A	N/A	N/A	N/A	Batch	6.5	14	N/A	N/A
Polysacchrides	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7	N/A	N/A	N/A	N/A	Batch	6	17	N/A	N/A
F. Vesiculosus	39.7	4.3	2.344	2.4	13.56	12.3	2.4	11.43	9.53	28.78	N/A	5.56	37.7	5	Hβ zeolite	5	N/A	N/A	N/A	100	Batch	15.2	N/A	N/A	N/A
F. Vesiculosus	39.7	4.3	2.344	2.4	13.56	12.3	2.4	11.43	9.53	28.78	N/A	5.56	37.7	5	Hβ zeolite	10	N/A	N/A	N/A	100	Batch	17.5	N/A	N/A	N/A
F. Vesiculosus	39.7	4.3	2.344	2.4	13.56	12.3	2.4	11.43	9.53	28.78	N/A	5.56	37.7	5	Hβ zeolite	15	N/A	N/A	N/A	100	Batch	27.6	N/A	N/A	N/A
F. Vesiculosus	39.7	4.3	2.344	2.4	13.56	12.3	2.4	11.43	9.53	28.78	N/A	5.56	37.7	5	Hβ zeolite	20	N/A	N/A	N/A	100	Batch	26	N/A	N/A	N/A
F. Vesiculosus	39.7	4.3	2.344	2.4	13.56	12.3	2.4	11.43	9.53	28.78	N/A	5.56	37.7	5	Hβ zeolite	25	N/A	N/A	N/A	100	Batch	24.5	N/A	N/A	N/A
Pine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20	KOH	2	N/A	N/A	N/A	500	Batch	65	26	N/A	N/A
Pine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	HCl	2	N/A	N/A	N/A	500	Batch	52	28	N/A	N/A
Pine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	H2SO4	2	N/A	N/A	N/A	500	Batch	45.5	32	N/A	N/A
Pine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Solv-C4H10O2	N/A	N/A	N/A	N/A	500	Batch	41	35	N/A	N/A
Pine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Solv-C6H15NO3	N/A	N/A	N/A	N/A	500	Batch	45	31	N/A	N/A
Pine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Solv-C4H10O2-C6H15NO3	N/A	N/A	N/A	N/A	500	Batch	52.5	27	N/A	N/A
Cow manure	43.96	4.78	1.27	1.04	48.95	16.27	N/A	4.96	28.77	15.03	N/A	29.45	10.04	0.5	Na2CO3	5	400	16	N/A	N/A	Batch	8.23	34.27	26.64	30.87
Cow manure	43.96	4.78	1.27	1.04	48.95	16.27	N/A	4.96	28.77	15.03	N/A	29.45	10.04	0.5	Na2CO3	5	400	18	N/A	N/A	Batch	16.08	16.61	26.84	40.47
Cow manure	43.96	4.78	1.27	1.04	48.95	16.27	N/A	4.96	28.77	15.03	N/A	29.45	10.04	0.5	Na2CO3	5	400	20	N/A	N/A	Batch	18.05	14.12	25.31	42.54
Cow manure	43.96	4.78	1.27	1.04	48.95	16.27	N/A	4.96	28.77	15.03	N/A	29.45	10.04	0.5	Na2CO3	5	400	22	N/A	N/A	Batch	21.23	12.34	22.01	44.43
Cow manure	43.96	4.78	1.27	1.04	48.95	16.27	N/A	4.96	28.77	15.03	N/A	29.45	10.04	0.5	Na2CO3	5	400	24	N/A	N/A	Batch	19.53	10.82	23.12	46.54
Cow manure	43.96	4.78	1.27	1.04	48.95	16.27	N/A	4.96	28.77	15.03	N/A	29.45	10.04	0.5	Na2CO3	5	425	12	N/A	N/A	Batch	5.14	45.13	29.91	19.83
Cow manure	43.96	4.78	1.27	1.04	48.95	16.27	N/A	4.96	28.77	15.03	N/A	29.45	10.04	0.5	Na2CO3	5	425	14	N/A	N/A	Batch	10.54	27.4	27.33	34.735
Cow manure	43.96	4.78	1.27	1.04	48.95	16.27	N/A	4.96	28.77	15.03	N/A	29.45	10.04	0.5	Na2CO3	5	425	16	N/A	N/A	Batch	17.2	14.4	25.49	42.3
Cow manure	43.96	4.78	1.27	1.04	48.95	16.27	N/A	4.96	28.77	15.03	N/A	29.45	10.04	0.5	Na2CO3	5	425	18	N/A	N/A	Batch	21.86	12.57	23.3	42.35
Cow manure	43.96	4.78	1.27	1.04	48.95	16.27	N/A	4.96	28.77	15.03	N/A	29.45	10.04	0.5	Na2CO3	5	425	20	N/A	N/A	Batch	21.28	12.08	24	42.65
Cow manure	43.96	4.78	1.27	1.04	48.95	16.27	N/A	4.96	28.77	15.03	N/A	29.45	10.04	0.5	Na2CO3	5	450	10	N/A	N/A	Batch	3,82	47.79	28.47	19.94
Cow manure	43.96	4.78	1.27	1.04	48.95	16.27	N/A	4.96	28.77	15.03	N/A	29.45	10.04	0.5	Na2CO3	5	450	12	N/A	N/A	Batch	9.24	30.76	26.37	33.63
Cow manure	43.96	4.78	1.27	1.04	48.95	16.27	N/A	4.96	28.77	15.03	N/A	29.45	10.04	0.5	Na2CO3	5	450	14	N/A	N/A	Batch	20.31	14.43	23.77	41.49
Cow manure	43.96	4.78	1.27	1.04	48.95	16.27	N/A	4.96	28.77	15.03	N/A	29.45	10.04	0.5	Na2CO3	5	450	16	N/A	N/A	Batch	21.05	11.43	24.59	42.94
Cow manure	43.96	4.78	1.27	1.04	48.95	16.27	N/A	4.96	28.77	15.03	N/A	29.45	10.04	0.5	Na2CO3	5	450	18	N/A	N/A	Batch	20.19	10.84	22.91	46.08

Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3	1	220	10	N/A	1500	Batch	28	N/A	N/A	N/A
Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3	1	220	20	N/A	1500	Batch	28.5	N/A	N/A	N/A
Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3	1	220	30	N/A	1500	Batch	28	N/A	N/A	N/A
Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3	1	260	10	N/A	1500	Batch	31.5	N/A	N/A	N/A
Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3	1	260	20	N/A	1500	Batch	38.5	N/A	N/A	N/A
Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3	1	260	30	N/A	1500	Batch	30.5	N/A	N/A	N/A
Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3	1	300	10	N/A	1500	Batch	9	N/A	N/A	N/A
Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3	1	300	20	N/A	1500	Batch	5	N/A	N/A	N/A
Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3	1	300	30	N/A	1500	Batch	2	N/A	N/A	N/A
Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3/Fe	1	220	10	N/A	1500	Batch	17.1	N/A	N/A	N/A
Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3/Fe	1	220	20	N/A	1500	Batch	20	N/A	N/A	N/A
Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3/Fe	1	220	30	N/A	1500	Batch	12	N/A	N/A	N/A
Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3/Fe	1	260	10	N/A	1500	Batch	7	N/A	N/A	N/A
Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3/Fe	1	260	20	N/A	1500	Batch	13.5	N/A	N/A	N/A
Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3/Fe	1	260	30	N/A	1500	Batch	22.5	N/A	N/A	N/A
Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3/Fe	1	300	10	N/A	1500	Batch	10	N/A	N/A	N/A
Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3/Fe	1	300	20	N/A	1500	Batch	6	N/A	N/A	N/A
Sawdust	47.46	4.63	0.34	0.3	45.28	14.59	N/A	N/A	29.91	33.01	N/A	32.51	N/A	70	Na2CO3/Fe	1	300	30	N/A	1500	Batch	3	N/A	N/A	N/A