Hydrothermal Liquefaction Conversion of Lignocelluloses and waste Biomass Using Zeolite Catalyst

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Abstract
The conversion of biomass into higher-value fuels is among the most famous feasible avenues for misuse of the stuff. At present, hydrothermal liquefaction is considered one of the most powerful methods for transforming wet biomass into bio-crude, but needs costly upgrading therapies to be used as biofuel. It is important to use catalysts capable of directly enhancing the bio crude yield also efficiently of the reaction course. The value for increasing the total productivity of the operation. The effects on the yield of bio-crude and the effect of heterogeneous catalyst addition. A typical catalytic activity was established in lignocellulosic biomass hydrothermal liquefaction, causing the different catalysts to be divided four distinct classes (transition metals, lanthanides oxides, alkaline metal oxides, and zeolites). A hydrodeoxygenation action of the catalysts effect on quality, bio-crude yield, and it illustrates the working environments used. A highest yield of the use of bio-crude has been confirmed Metals and lanthanide oxides are transferred. That can concurrently guarantee high-production bio-crude quality. This study's goal is to objectively summarize the impact of the added of zeolite catalysts on lignocellulosic biomass hydrothermal liquefaction,with a special emphasis on improving bio-crude yield and efficiency. It also highlighted the typical catalytic effects corresponding to zeolite catalysts.

Keywords: Zeolite, hydrothermal liquefaction, Lignocellulose, biocrude oil, waste.

1.Introduction:
Scientists and researcher looks around the same moment, for renewable energy infrastructure harmless to the environment when they see that the fossil fuels limited availability and they have a serious concern in terms of concentration greenhouse emissions in the atmosphere and global energy demand is rising. In recent years, the researchers found a renewable and available alternative energy from biomass. Because of the water and high oxygen content of biomass, it (high heating value: 10–20 MJ/kg) has a low energy density, which results in restricting the use of biomass[1], the kind of biomass effect on the properties of renewable fuel. The most practical method of manipulation is conversion biomass into more useful and easy-to-store fuels like syngas and bio-oil [2-4]. The Directive 2009/28/EC [5] created a distinction between traditional (first generation) and advanced subsequent [and second generation] biofuels in the European Union.. Actually, agricultural crops such as wheat, maize and sugar cane are the main source of biomass from which the first generation of biofuels are produced, but it is not recommended to spread them to a large extent because of their negative impact on food availability and biodiversity [6]

There are some problems related to the first generation of biofuels, and to solve them the use of biomass must be studied and applied successfully, as well as determining the development of the second generation of biofuels where a large part of the lignocellulosic biomass is produced, such as agricultural residues and forestry[7] or waste, like paper, manure and sawmills[8-10]. However, In comparison to lignocellulosic biomass, the molecular structures related to biomass used in the manufacture of the first generation of biofuels are more complex, and the energy density is limited, and this all leads to problems in the conversion
techniques for the production of biofuels as well as the distribution of the raw biomass. And it must continue to make more research efforts to lower the cost of the second generation of lignocellulosic biomass-based biofuels and make its production competitive despite the great research efforts and the work of the research and development sectors in the industry[11]. Reducing the cost production of biofuel is important to address the problems of low biomass energy density, low efficiency in conversion processes, as well as distribution system problems for produced biofuels [12]. There are two types of converting biomass to biofuel processes: biochemical and thermochemical. [13, 14][15-17] Thermochemical processes are considered one of the most suitable processes lignocellulosic biochemical conversion, where this decomposition Because of the strong crystalline density in the lignin matrix, it is more difficult to ferment than fermentable biomass and organic matter from food crops, and among these thermochemical processes are hydrothermal liquefaction, gasification and As well as pyrolysis, which works under high pressure, temperature or both[18].

The reaction rates for these processes are higher, and therefore the reactor dimensions are lower [19] Thermal liquefaction is one of the most important techniques for producing liquid fuels referred to as bio-crude. During this process, the moist biomass is transformed into liquid fuel in a high-pressure reactor (5–30) MPa and mid temperature [250 – 400] °C when an organic solution and water are mixed, with the most common being ethanol, propanol, phenol and methanol [20-22].

The advantages of using water as a solvent present are: Water is a friend of the environment; the biomass naturally contains water and the specific properties of water assumes near its critical point [374°C and 22.064 MPa] in HTL conditions, a dielectric constant and viscosity are lower, thus increasing the solubility of the hydrophobic organic compounds and by providing catalytic activity for acid based reactions increases the ionic product, so the HTL processes are carried out at lower temperatures as they do not need to be dried first, and thus consumes less energy when opposed to conventional pyrolysis approaches.

Dielectric constant and viscosity are lower, thus increasing the solubility of the hydrophobic organic compounds and by providing Acid-base reaction catalytic activity increases the ionic product [23], so the HTL processes are carried out at lower temperatures as they do not need a preliminary drying procedure of the biomass and thus consumes less energy compared to the traditional pyrolysis processes [24].

The resulting biofuel from HTL process is a higher quality than that produced by pyrolysis, and the heating value (HHV) is higher due to the low concentration of oxygenated compounds [25, 26]. Water has been produced during HTL, and also produces CO2, CO through decarbonization, dehydration and decarboxylation reactions where oxygen molecules are partially removed and a large amount of oxygen remains despite the fact that this process is of better quality, producing unstable bio-fuel with low heating value (HHV) and high viscosity and acidity [27, 28]. Its properties depend largely on the biomass used and the operating conditions [29, 30], and the bio-crude goes through several development treatments such as catalytic cracking and hydrotreating for later use as an alternative to transportation fuels [31, 32].

The production of fossil fuels is still largely due to the remodeling of natural gas steam, and studies are still ongoing to search for renewable sources for the production of hydrogen necessary for the development and promotion of biofuels [33].

The HTL research activity therefore focuses primarily on the manufacture of appropriate catalysts for improvement the yield of bio-crude and efficiency, and on the upgrade of bio-crude in situ. There has been extensive research usage of acidic acid or alkaline homogeneous catalysts (H3PO4, HCl, Na2CO3, K2CO3, Ca (OH)2, NaOH, KOH etc.)[34-38]. Research results found an increase in the production and quality of biofuels when adding these catalysts, but costly The homogeneous structure of these catalysts necessitates separation processes aimed at separating catalysts at the end of the reaction, as well as corrosion-resistant machinery, [39, 40].

In fact, the recovery of the catalyst in the homogeneous catalysis is difficult and very costly, so that the catalyst is discharged with the water step and the necessary neutralization treatments at the end of the process.
should be requested. For instance, depending on the quality of the catalyst chosen, adding acidic or basic compounds will increase the cost of the operation. [41].

Recently, the use of heterogeneous catalysts has been extensively explored due to their high action and ease of recovery from liquid materials, making them ideal for re-use, resulting in a decrease in the high costs associated with the entire bio-crude supply chain, thereby facilitating large-scale processing. In addition, they also increased thermal stability and are non-corrosive [42]. Despite the benefits of heterogeneous catalysts, they are usually less active than homogeneous catalysts due to the external/internal diffusion limitations associated with liquid-solid and gas-solid reactions. [43].

2. HTL with Feedstock of Waste

As a possible feedstock, several forms of waste have been investigated. For processing of bio-crude[43, 44]. The feedstock studied is, in general, seven categories can be categorized:

1. Waste and residues from agriculture.
2. waste from forestry.
3. waste from food production.
4. Algae.
5. Livestock.
6. solid waste from water and industrial waste.
7. The waste of plastic.

Agricultural residues and waste (like stalks of corn, rice, and wheat Straw, etc.) are biomass materials abundantly available that Agricultural operations can be accessed and collected easily. These ones, these in general, the percentage of saccharides in biomass materials is high (more than 50 percent), cellulose, hemicellulose and lignin of 10 to 20 percent , a small amount of lignin protein, as well as extractive substances [45].

The approximate to liquefy these saccharide-rich agricultural products, raise the reaction temperature. Usually requires 280-300 °C in pressurized hot water, fabrics. High water-soluble yield In comparison, the yield products of bio-crude are relatively low, (more than 50 wt. percent). It can be achieved. Barley straw, for instance, with a high content of Saccharide [46 percent cellulose, 23 percent hemicellulose] has been liquefied at the site. The temperature in water medium, N2 gas setting, from 280 °C to 400 °C. And as a catalyst for K2CO3 [45]. A 300 °C reaction temperature. It was determined that the yield of biocrude yield was optimum, and 34.9 percent wt. and a relatively high water-soluble yield of (~58% wt.). Land residues contain forest waste as opposed to crop waste and residues. A larger volume of lignin (approximately 30 percent), this makes the liquefaction process more complex; consequently for the degradation of lignin, a higher reaction temperature [near critical point] is needed. Performance of a solid Residue is usually high [30 to 40 percent wt.] due to the high percentage of residue. Although The oil yield resulting was rather low (about 20 wt.), the content of lignin as reported by Wang et al.[46]. Sawdust that has liquefied of pinewood in medium water at (375 °C) temp.,60 min time, the atmosphere of the presence of N2 gas as a catalyst for K2CO3. Just a small amount of oil was produced as a result 17.3 percent by weight, although the solid residue yield was relatively high, 40 percent by weight bio crude created. The HHV was (30.8 MJ/kg) and contained (56.4 percent) of the oxygenated volume. HTL of wood mixtures at Range of temperature (390 to 420 °C) in the continuous reactor in the presence of (K2CO3), has been performed a high rate of yield of bio-crude has been recorded (45.3 percent wt.). The use of a continuous system in comparison to a batch reactor [46] [47] may be due to one potential explanation because of the high yield of bio-crude. Sadly, the effect on HTL biocrude of the reactor type in rare cases, performance investigation has been established and In the future, further research on this subject will be expected in research programs. organic waste from the food production process is food processing waste. Industries, such as restaurants and food producers, typically have a high protein & lipid content (a maximum 30 to 50 percent). Hydrothermal liquefaction is taken into consideration as an acceptable technology capable of transforming such a high protein to lipid content systems crude bio-oil as a feedstock with a reasonably under a crude bio-oil, a high oil yield .Mild in comparison state of response at (~280 °C) [48-50]. As an example, (SCG) spent coffee grounds, containing...
(15 percent) lipid and (17.4 percent) protein, in the N2 atmosphere, subcritical water has been liquefied to create bio-crude oil at a reaction temperature between (200 °C to 300 °C) and a response time of (5 min to 25 min) [48]. A Limit Acetone-recovered biocrude yields were (47.3 percent) at (275 °C) in (10 minutes), with an HHV of (31.0 MJ/kg) much higher than that of SCG (20.2 MJ/kg). The swine and cattle manure are the two most prevalent animal waste that have been investigated through HTL [51, 52] for crude bio-oil production. In Xiu et al. [51], swine manure used had a high crude protein content (17.10 percent) and lignin (less than 1 percent), saccharide (~ 35 percent), and ash The Material (22.3 percent). As well, at reaction temperatures ranging from (260 °C to 340 °C) for (15 min), in nitrogen gas the swine manure HTL was performed. At (340 °C) temperature with an HHV of (36.05 MJ/kg), the maximum yield of bio-crude (24.2 wt. percent) was obtained.

The key compounds that were obtained in the Biocrude phenols, carboxylic acids and carbonyls have been identified. GC-MS, which can be obtained in swine manure from the protein content, also A certain amount of nitrogenous compounds was discovered. Microalgae are known to be the feedstock of the third generation and to be Because of their superiority over lignocellulosic terrestrial biomass, in different climates, shorter growth cycles and strong adaptability, water bodies and marginal land, which are also highlighted as marginal land and water bodies, candidate who has the most promising for development of biofuels [53-55].

Nanochloropsis normally, sp. (Green marine algae) is rich in lipids (28 percent) and proteins (52 percent) content [55]. In the water medium, it was liquefied at the temperature the reaction time ranges from (200 °C to 500 °C) and in 60 min of time. The Limit Biocrude yield was achieved at the temperature of (43 percent wt.) 350 °C with a higher value of (39 MJ/kg) for heating.

Seaweed Green (Dunaliela Tertiollecta) also included a high proportion of crude fat (20.50 percent) and crude protein (63.6 percent) and was subjected to HTL for 5 min and 60 min at T from 50 °C to 340 °C [56].

The highest one, a 43.8 percent oil yield was obtained at a temperature of 300 °C, 5 min for time with a calorific value of (34.0 MJ/Kg), and 5 min reaction time with a calorific value of (34.0 MJ/Kg). The 340 °C temp and 60 mint times, reaction conditions resulted in the lowest viscosity and oil level. The principal components of the derived bio-crude are Long-chain fatty acids, ketones, were from the HTL of microalgae, fatty amides and other compounds which contain nitrogen [55-57]. Sewage of sludge is a type of high-moisture organic waste. Content that is created from the process of waste water treatment. Landfills, ocean disposal and incineration have disposed of a substantial volume of such waste [58].

They announced that the highest yield of oil (24 percent wt.) was obtained at (350 °C) temp and time of reaction (60 min), while the highest energy density of (35.4 MJ/Kg) was obtained at temperature (280 °C), which was far higher than that of (18.30 MJ/Kg) crude sludge powder. For instance plastics as polypropylen, Polyvinyl chloride polyethylene, and polystyrene is a semi-synthetic or synthetic polymer with a high petrochemical-derived mass of a molecule. Account for waste plastics owing to their resistance to deterioration, poor recycling rate (< 10 percent) and low-grade use, about (10 percent) of landfill trash by mass, and the disposal of waste plastics have created significant environmental problems worldwide. Alternative approaches for the disposal of waste plastics have been extensively researched for reuse and recovery of energy. Not much has been studied regarding the plastic waste liquefaction in subcritical water. Wang et al. [59] recorded that (8 percent) biocrude yield was obtained for time (30 minutes) by liquefying plastic waste hydrothermally at temperature (300 °C). It is noteworthy that is followed by hexane using solvent benzene, plastic bio-crude was recovered. Wu et al. [60] also indicated that only around (1.8 percent) bio-crude yield (dichloromethan-based extraction) was produced from polypropylene HTL at temperatures ranging from (320 to 370 °C) and 0-40 min time. Supercritical water used by Pedersen and Conti [61] High-density plastics such as polycarbonate (PC), polymethyl methacrylate (PMMA), polybutylene terephthalate (PBT) and biocrude yields ranged dramatically from (0 wt. percent to 99.8 wt. percent) and temperature (400 °C for 15 min) to liquefy.

In short, the bio-crude yield of single feedstock HTL is very high. Depending on the proportion of various constituents of the chemical in the with feedstock. Carbohydrate-rich cultivation and forest waste typically
results in relatively low biocrude yields. Algal biomass (protein & lipid rich microalgae) since the bio-crude yield is normally higher than that of other feedstock; it is called a favored feedstock.

Bio-crude derived from microalgae, however, has a high content of N-containing compounds which require a further process of denitrogenating. HTL may also be a solution for dealing with waste from food manufacturing, sewage sludge, waste from animals and even plastic waste.

3. Lignocellulosic biomass hydrothermal decomposition pathways

Lignin, Cellulose, hemicellulose, and extractives are primarily composed of lignocellulosic materials in various proportions; cellulose is usually the largest fraction (35 to 55 percent), after that hemicellulose (20 to 40 percent) and lignin (15 to 25 percent) [44]. Lignocellulosic biomass macromolecules are first hydrolyzed and then decomposed into compounds of low molecular weight during the HTL process. Water soluble compounds such as dihydroxyacetone, hydroxymethylfurfural and glyceraldehyde are primarily formed by cellulose and hemicellulose decomposition, any of these materials, however, are unstable and participate in condensation reactions that result in water-insoluble compounds (bio-crude) and char [46]. Alternatively, lignin is a structure made up of polymers made up of aromatic ring-containing monomers normally found in monolignols [54]. The monomers are linked together by various chemical groups and forms of bonds. The decomposition of lignin HTL will produce a variety of compounds that will exist in solid, liquid, and gas phases. The aromatic portion of lignin is, in fact, the precursor to oligomers and phenolic compounds that can be condensed to contain water insoluble compounds and charcoal. Simultaneously, methane and methanol can be produced by breaking down lateral alkene or alcohol groups; water-soluble compounds (as acids) can also be produced by breaking down lateral alkene or alcohol groups [55].

4. The advantages and disadvantages of the use of water as a reaction medium.

The reaction medium most used in HTL is water, and act as a solvent as well as a catalyst in hydrothermal environments [40, 41]. Water's viscosity is lower and organic compound is higher solubility near the critical point. This activity directly improves the efficiency of reactions, bio-crude quality and yield [42].

Approximately as previously stated research in the liquefaction treatment, (50.0 to 70.0) wt. percent can be converted from biomass to various products, when use an aqueous medium near 50 percent of yield bio crude was obtained [30, 43–45]. It should be remembered that the "conversion of biomass" By extension, the percentage of biomass that is processed into HTL products indicates that Currently (100 percent - percent unreacted biomass) is assessed by.

In fact, however, the mass unreacted of biomass is complicated, not necessarily feasible, since most biomass would react under heated HTL conditions, but some of biomass may stay unreacted, especially at conditions reaction (lower T) [46].

Lie et al. [47] studied solid HTL products, found unresponsive biomass at comparatively temperatures. Their suggestion was that the lower temperatures are sufficient for conversion. hemicellulose and lignin, a higher temperature is needed to break hydrogen bonding in cellulose. The solid residue (SR) may also produce both at moderate reaction cond. (lower T or limited time spent in residence), bio char and unreacted biomass, so someoem polymeric high molecular weight MW materials produced by aqueous condensation or liquid oily. Unreacted bio char, biomass and high MW items are typically lumped; as solid residue SR in the HTL literature and the percent biomass conversion is usually determined for approximation by (100 percent - percent SR). The disadvantage of using water only as a solvent, a portion of the organic compounds formed can pass to the aqueous phase or solid residues, resulting in a loss of absolute bio-crude yield.

In order to resolve that issue, Chemical solvents, like ethanol, CH3OH, glycerol and aceton have been tested. In biomass liquefaction, ethanol is often embraced as it is sustainable, serves as a donor of hydrogen and working to promote high yield of bio-crude in moderate and higher heating value (HHV) [49,50].

Although using of co-solvents for alcohol pure or alcohol water pure, clearly shows effects on liquefying biomass positively, few experiments have considered that alcohol may be ingested and not considered as the input substance. Hence, a system for estimating the indirect balancing carbon can assess alcohol amount loss.
in the liquefaction [4]. Unlike using water as a solvent in which products of liquids are separated into (soluble, insoluble) water sections, the fraction of the liquid of HTL that use solvent alcohol is a mono phase, crude from biomass obtained simply by allowing alcohol to evaporate. While corrosion minimized relative to H$_2$O, application of C$_2$H$_5$OH as a solvent in its purest form dramatically increases the cost of operations [42]. Using water-ethanol is alternative with pure alcohol as a solvent. As the reaction medium, blends with good findings recorded for many biomasses in the literature [49,51,52]. More significantly, during liquefaction, favorable synergistic associations occur between ethanol and water, resulting in higher bio-crude yield and efficiency. Chenge et al. [53] reported result contrasting the HTL of alcohol (methanol & ethanol) with pine sawdust, water & a water alcohol mix as the reaction medium. When using a mix instead of mono-solvent, conversion of biomass has doubled as well as yields of bio-crude have tripled. Widely accepted theory that cellulose and hemicellulose hydrolysis are aided by water, while ethanol promotes depolymerization of lignin [51]. Using water as a reaction medium, substrate degradation has a critical issue. Subcritical water's comparatively high density and polar properties contribute to a much more extreme environment under acidic & oxidizing conditions. In traditional materials, it is possible to experience rapid corrosion, so costly and special alloys are necessary [54].

Ni, Titanium alloys demonstrated acceptable level of tolerance to solutions (alkaline & acids) straightly, among several materials tested under subcritical conditions [55-57]. Nevertheless, Ni or Ti alloys has minimal mechanical strength in high pressure and high temperature applications. [58]. Vulnerability to corrosion known to be flaw in the use of water.

5. Characteristics of the products of HTL

Four main products are produced by Biomass HTL treatment, namely bio crude, water soluble products (WSP), and the solid products (bio-char). High temperature (250 to 500 C) gaseous products and pressure (5 to 35MPa), and (water or alcohol water mixture) co-solvents with or without homogeneous/heterogeneous catalyst [11, 12].

5.1 Bio-crude

HTL's principal goal is to maximize the yield and biocrude properties of large chemical compounds and physicochemical properties. Bio-crude is a combination of chemical compounds, mostly grouped by functional groups into alcohols, aromatics, ketones, aldehydes, carboxylic acids & (straight or cyclic) hydrocarbons [59].

This large variety of chemicals suggests as a natural biofuels or bio-based additives origins, bio-crude [60]. In comparison, high-cost refinement and the need for upgrades are important. to distinguish compounds of interest of some for chemical applications [61] as well as disadvantages associated with bio-crude, in other words, it is important to resolve low heating values (Compared with sources of petroleum), high (viscosity& strength) and chemical instable properties corrosive conduct [62].

Operational parameters of HTL, such as temperature and time of residence, affect the properties and yield of bio-crude [44]. The temperature ranges between 250 and 500 C, and the time of residence varies between 0 (at the same time) to some minutes [63]; Even then, there is no general reaction (T or t )of residence is sufficient for any HTL treatment.

In order to facilitate bio-crude yield or a chemical compound of interest [17], all parameters are chosen accordingly. Catalysts are widely used to improve yield of bio-crude and efficiency in the biomass hydrothermal liquefaction.

5.2 Other products of liquefaction

The aqueous process, although it is a side product, is an important one. HTL production fraction. The aqueous phase's composition varies depending on the feedstock and reaction conditions, but it's often made up of water and the other solvents, (if any), water soluble light organic compounds. [40],[64]
An aqueous phase most important functional chemical group, overall such organic compounds present in the aqueous phase include: [65] are acetic acid, formic acid, glycolic acids, ethylene glycol, phenol, methanol, ethanol and lactone. A solid by-product, in addition to the bio-crude and an aqueous phase, is often referred to as char or biochar, produced during the HTL of biomass. The mechanism of biochar formation is still uncertain, but it is unclear. It has largely been agreed that it is made up of additional oil fraction Reactions of polymerization with long residence time [66].

The gaseous phase, which is mainly CO2 with smaller CO, H2, and CH4 fractions, is the final portion of the HTL products. During the liquefaction process, these compounds are formed by biomass decarboxylation and cracking reactions. [40].

6. Catalysts of Zeolite for HTL phase

Zeolites are aluminosilicate porous minerals commonly used in various processes of chemical conversion as a catalyst and as reinforcement. In hydrothermal biomass liquefaction, various kinds of zeolites have been studied and improved the biomass to liquid converts goods ZSM-5 was used to obtain these results. Zeolite is efficient catalyst commonly used in deoxygenating processes of bio-crude upgrade treatments due to their acidity and form selectivity [67]. The research findings that using these materials demonstrated a small increasing of yield bio-crude and efficiency, supporting the strong behavior of cracking, hydration, and cyclization reactions in zeolites.

The amount of zeolite used, on the other hand, increases as the amount of zeolite used increases, due to the obstruction of active pores, the char created elevated determining catalyst deactivation. So to explain an influence of the Ni/HZSM-5 catalyst on HTL of pine sawdust, Cheng et al. [68] conducted experiments only with HZSM-5 in environment operating mentioned above.

Using a catalyst HZSM-5, while solid reside reduces, the bio crude and the gas yields increase. GC-MS study found a decline a greater concentration of hydrocarbons and an increase in oxygenated compounds due to the addition of zeolites. Dehydration, cracking, and oligomerization reactions have converted oxygenated molecules to hydrocarbons. [69] Promoting the formation of higher bio-crude hydrocarbons. Yan et al. looked into effect of adding ZSM-5 in HTL bagasse made from sugarcane. [49] and water solvent without a catalyst, highest yield near (35.40 wt. percent) obtained in temperature 285.0 C and 200.0 ml of water, 10.0 gm. of biomass, a 30 minute reaction period. The addition of the catalyst ZSM-5 increased bio-crude production by lowering acidic components while lowering yields of bio crude.

Tests performed with the addition of different amounts of ZSM-5 catalyst from (10.0 to 90.0) wt. percent respecting to weight of biomass (w) revealed that an improvement in charre yield when the yield of bio crude was increased by added zeolite when bio-crude yield was increased

Reverse pattern. Esters were the main compounds found in the presence of zeolite among water-soluble compounds, whereas reduced acidic compounds were greatly.

That indicates the zeolite has a catalytic activity in the reactions of esterification. Important variations were also observed in furfural concentrations; in the presence of zeolite: The amount of furfural decreased as a result of zeolites' catalytic activity on the conversion of furfural to phenolic compounds, lowering the content of carbon. There is greater consistency and higher HHVs for the bio-crude obtained from zeolite. The occurrence of increased concentrations of zeolite also influenced the composition of the gas, although a higher concentration of CH4 was found in H2 in fact. From these findings, zeolites prefer hydrogination and methantion reaction.

7. Yield and quality of bio-crude

Heating value for the bio crude provided by a thermochemical process is one of the most immediate properties for determining the consistency. That property is notable besides because of the final use of bio-crude, which is usually the basis for the refining of biofuels, but also because HHV can be used as an indicator of the oxygen content of the oil.
Zeolite catalysts display an intermediate appearance due to their operation on the deoxygenation reactions compared to bio-crude quality enhancement. The mean relative values of HHV. and bio crude yields stated as a classification-related function of the catalytic converter generated. Alkaline earth metals lead to higher WI, degrading bio crude materials, while when zeolites are used, a decrease in bio crude with higher HHV is recorded. Technologies have been widely used to generate renewable fuels for a long time. Bio-diesel and bio-ethanol, for instance, already commercially available, that provided from vegetable oil transesterification and sugar fermentation, respectively.

Feedstock, however, from food sources, lead to fears about food vs fuel questions. For that reason, it is better to build technology using non-food feedstock [32], such as, HTL bio crude may be a promising option because it can be further refined into a variety of fuels. Lignocellulosic materials are used to mitigate the problems created by fossil fuel depletion; global warming, rising global warming population that began in the 1940s.

Appell et al. liquefied waste which much cellulose (such as urban waste, agriculture waste, sludge, and biomass) at temperature 350-400 C and pressure of 28 MPa at the Pittsburgh Energy Recovery in 1970 to produce low sulfur oil. With a bio-crude production of 40-50 per cent, more than 90 per cent conversion was achieved. Though their results were optimistic, they distributed oil and dominated the project.

HTL has bio crude chemical properties that are special than fossil gasoline. Organic acids, aldehydes, phenols, ketones, and other oxygenated compounds derive from the depolymerization of biomass products, whereas petroleum-based oils often contain no oxygen. [61].

Bio-crude has a higher overall acid number (TAN), which is linked to corrosion issues. While petroleum fuels have a TAN of less than 0.50.

8. Perspectives for the Future

Technologies for biomass conversion, in the other side, are insufficient advanced to compete with materials directly dependent on fossils. As a result, still we can’t comparing products of HTL with those dependent on petroleum [70].

Over the last decades, research on HTL has progressed dramatically. And promising outcomes. New TEA and pilot plants demonstrate promising Results for HTL technology's future. The next challenge lies in reducing commodity refinement costs and exploring consumer insertion approaches. Circular economics and life cycle research analyses (LCA ) are critical to this method, in the case of a feasibility study.

In addition, there could be a need for government intervention in the first the commercial introduction period of HTL related goods. For e.g., a high carbon tax could minimize total HTL cost-effectiveness and competitiveness with petroleum [71]. This will raise the participation of industrial sectors in biomass processing and further promote the growth of HTL technology.

9. Summary

An easy way to generate liquid is hydrothermal liquefaction lignocelulosic biomass biofuels. So aim of this investigation is to provide information on recent developments involving the use of HTL zeolite catalysts. Using of heterogeneous catalysts in the technology of HTL appears to be a feasible and substitute for homogeneous catalysts, which, due to the prospect of retrieving and at the end of the reaction, reusing the catalyst, will greatly minimize the total costs associated with this technology. Actually, transition metals and lanthanide oxide are active catalyst groups in terms of both yields and quality of bio-crude enhancement, leading to a 38 percent rise in bio-crude yield and a 19 percent increase in HHV over the blank test. The incorporation of the catalyst for alkaline earth metals contributed to the largest yield of bio-crude near (40.0 percent) but 10 percent lower than that generated if not using a catalyst characterized by an HHV.
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