Hydrothermal Liquefaction Process (HTL) of Sugarcane Bagasse for the Production of Bio-Oil

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Abstract - *Hydrothermal liquefaction is a favourable process to convert high moisture lignocellulosic biomass into alternative liquid oil. HTL was applied to observe the feasibility in transforming Sugarcane Bagasse to renewable resource of energy and valuable dissolved organic chemicals. HTL was conducted at 250 °C and retention time of 30 minutes. The bio-oil yield of oil 1, Oil 2 and Oil 3 7.9 %, 6.3 % and 7 % obtained at 250 °C. FTIR and elemental analysis Moreover, oil contains less oxygen and nitrogen contents and consequently high in its heating value.*

***Key Words*: HTL, Sugarcane Bagasse, Bio-oil, lignocellulose, Elemental Analysis**

1. INTRODUCTION

The development of biomass to biofuels for the production of chemicals, fuels and energy has become a essential to stand the dependency on fossil fuels which meet energy demand and reduce carbon dioxide emissions [1]. Biomass is defined as the renewable organic material which is having potential for biofuels and originates from plants, including their derivatives [2]. It is abundant and is considered as neutral for respective carbon emissions [1, 3]. In particular, lignocellulosic biomass has great potential to be utilized since it does not compete with food resources [4,5]. Hydrothermal liquefaction (HTL) is a promising process and techniques to convert high moisture lignocellulosic biomass into liquid chemicals and fuels.

HTL is used for bio-oil production in which the reaction of biomass in water at elevated temperature (200–370°C) and high pressure (2–20 MPa) with or without using a catalyst is done [6]. HTL does not require dewatering and drying steps, and therefore, it is suitable for processing aquatic biomass and this reduces the cost of production of bio-oil. But, HTL require more expensive and elaborated safety systems with trained manpower [7].

Lignocellulosic biomass is considered as a renewable and sustainable feedstock for the production of bio-fuel, chemicals, and electricity. In recent years, hydrothermal carbonization (HTC) has gained a great attention in the field of biomass utilization due to its several benefits particularly as a low energy intensity process. HTC can be operated at low reaction condition as compared with the other thermochemical conversion processes such as combustion, pyrolysis, and gasification [8]. Besides, water is used as a reaction medium during HTC, and it acts as reactant and catalysts, so wet biomass can be used and pre-drying step of biomass is inessential [9].

2. MATERIALS AND METHODS

2.1 Feedstock source and characterization

Sugarcane Bagasse was collected from the local area of Dehradun, Uttarakhand, India. This was then milled and screened to get particles with diameters smaller than 0.30 mm. The powders were dried in an oven at 110 °C for 24 h and then kept in a desiccator at room temperature which is used as the biomass feed stock. The proximate analysis of sugarcane bagasse was analysed by ASTM and elements analysis (CHNSO) was determined by a Flash 2000 CHNS/O Organic Elemental Analyser (Thermo Scientific) and the same are presented in Table 1.

Table - 1: Proximate and Ultimate Analysis of Sugarcane Bagasse

Weight % (on air dried basis)			
Moisture content	**Volatile matter**	**Ash content**	**Fixed Carbon**
9.1	74.5	4.7	11.7
Elemental composition(on dry basis) in wt %			

Carbon	Hydrogen	Nitrogen	Sulphur	Oxygen
44.91	15.18	8.9	0	31.52

2. 2 Experimental setup

The reaction was carried out in 150 ml vessel heated by an external electrical furnace, and the temperature was measured by a thermocouple and controlled within ±10 °C. In each reaction, 5 g (dry basis) of raw material powder and 50 ml de-ionized water were fed into the reactor. Reactants were agitated by magnetic stirring at 1400 rpm. With heating rate of 20 °C/min, reactions proceeded at specified temperature ranging from 240 to 255 °C for 120 min of reaction time. The average pressure inside the reactor during reaction was 20 bar. After 120 min, the reactor was kept for cooling to room temperature. Once the reactor was cooled to room temperature, the gas phase was removed through the exhaust pipe and the liquid and solid product was transferred into the beaker. The process is shown in Figure 1.

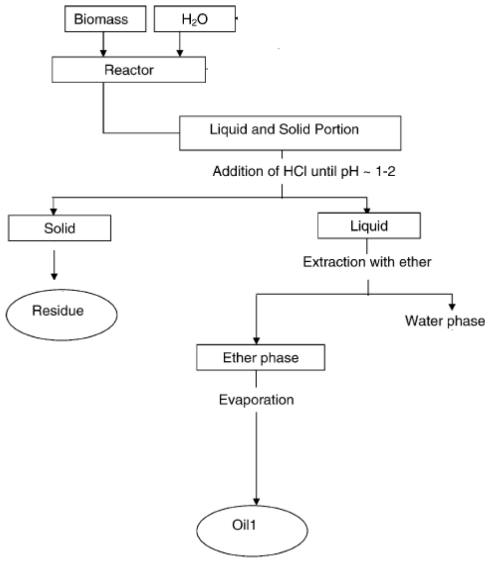

Fig -1: Extraction of Product from HTL

3. RESULTS AND DISCUSSION

The hydrothermal liquefaction of Sugarcane Bagasse at the temperatures of 250 °C by using water and ethanol is carried out in 150 ml reactor. The produced bio-oil was further characterized with its elemental composition and the heating value.

3.1 Bio-oil Yield

The bio-oil yield is basically the mass of the bio-oil divided by the mass of the dried feedstock. The bio-oil yields of oil 1, Oil 2 and Oil 3 were 7.9 %, 6.3 % and 7 % respectively. The ultimate analysis, atomic ratios and HHV of the bio-oil produced at 250 °C are listed in below table. The heating value of the bio-oil was in the range of 46.3 - 51 MJ/Kg.

Table - 2: Elemental composition and High Heating Value of the bio-oil (with and without catalyst).

Bio-oil	Weight of Bio-oil (gm)	Elemental composition (%)				HHV MJ/Kg
		N	C	H	O	
Oil 1	0.396	3.3	45.3	30.03	15.37	51.2
Oil 2	0.314	6.31	50.9	19.02	23.77	46.39
Oil 3	0.35	7.22	51.31	30.05	24.42	50.81

4. CONCLUSION

The bio-oil yield of oil 1, Oil 2 and Oil 3 were 7.9 %, 6.3 % and 7 % obtained at 250 °C. FTIR and elemental analysis Moreover, oil contains less oxygen and nitrogen contents and consequently high in its heating value. The output of this research represent that, HTL can increase the bio-oil yield at low temperatures and decrease its oxygen and nitrogen contents which makes the possibility for commercialization and pilot scale of this HTL study.

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