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Bio-Oil from Coconut Shells

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***Abstract:**Future decade's energy industries and startups can go for an innovation method of electricity generation using clean power mechanism by using the renewable energy and by utilizing the abundant Biomass wastes resources like husks, shells, powdery agri wastes, bagasse as fuels. Similarity to fossil resources, biofuels for heat power utility and electricity production benefits higher efficiency without environmental impact. Bio-Oil extracted from biomass, is a Carbon di oxide neutral technique and it will leads to credit among various resources of biomass coconuts are the surplus available source in the globe. Literature shows that research investigation in extracting the by product from coconut using pyrolysis is very limited. The objective of present work is to envisage the research methods for generating power from coconut shell using pyrolysis. Bio-Oil extracted from pyrolysis process can be used as a fuel for oil burners and in boilers for heat and power applications. Also Bio-oil can be blended at proper proportion with diesel to bio-diesel fuel. Hence pyrolysis based fuel extraction techniques are key solution to solve energy shortage in a friendly way using coconut shells.*

***Index Terms:** Coconut shells, Green Energy, Biomass, Pyrolysis.*

I. INTRODUCTION

Biomass is a hydrocarbon material consisting of carbon, hydrogen, oxygen, nitrogen and other components in small proportions. The use of the residual biomass as energy resource finds its typical applications from small ovens to boilers for both thermal and power applications. The thermo chemical processes of converting carbonaceous biomass are termed as combustion, pyrolysis and gasification [1]. The pyrolysis technique is an innovated energy conversion mechanism which is capable to produce cleaner, higher calorific gas from a diversified range of biomass. Pyrolysis technique products includes gases, vapor that can be separated as a liquid and solid char. Solid char consists of a small amount of volatile hydrocarbons, solid hydrocarbons, and inorganic compounds [4]. It involves the simultaneous change of chemical composition and physical phase, and is irreversible. The thermal treatment of coconut shells is accompanied by physicochemical and structural transformations. The calorific value and other elemental analysis of the coconut shell obtained from open literature are tabulated below.

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Table 1. Proximate & Ultimate analysis of Coconutshell

	[2]	[3]	[4]
Proximate			
Volatiles	72.93%	74.9%	85.36%
Fixed carbon	19.48%	24.4%	
Ash	0.61%	0.7%	3.38%
Ultimate analysis			
(%)	53.73%	53.9%	63.45%
Carbon	6.15%	5.7%	6.73%
Hydrogen	38.45%	39.44%	28.27%
Oxygen	0.86%	0.1%	0.43%
Nitrogen	0.02%	0.02%	0.17%
Sulphur	6.98%	5.7%	11.26%
Moisture content			
Calorific value(MJ/kg)	20.88	20.515	22.83

Pyrolysis experiments have been conducted by E. Ganapathy Sundaram et.al [2] using coconut shell at pyrolysis temperature between 400 and 600°C with particle size of 0.15 mm - 1.80 mm. The gas yield and liquid yield were reported to be increased from 43 to 38 wt% and 33 to 30 wt%, for a raise in operating temperature from 400 to 600°C. Mohammad Uzzal Hossain Joardder et.al [4] experimentally demonstrated the conversion of coconut shell into pyrolytic oil. The maximum oil yield of 34.3wt% was achieved at a temperature of 450°C for fuel size of 0.6mm.

Experimental results shows that yield of liquid was reported to be increased to maximum at 450°C and decreased at an operating temperature of 600°C.[4] reported that yield is maximum due to cracking of the coconut shells at this operating temperature.

II. PROCESS FLOW DIAGRAM

The schematic diagram of bio-oil extraction process, various subsystems and Bio-Oil applications are as shown in Figure.1 , Figure.2, Figure.3, Figurre.4 and Figure.5

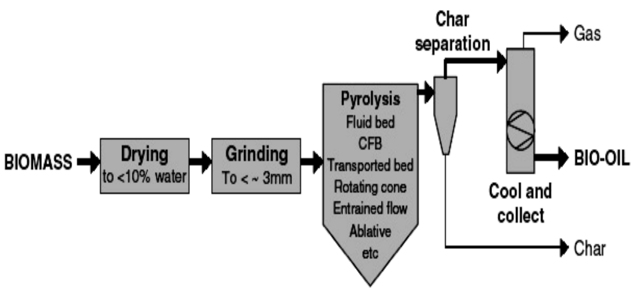

Figure 1.Schematic view of a Pyrolyser

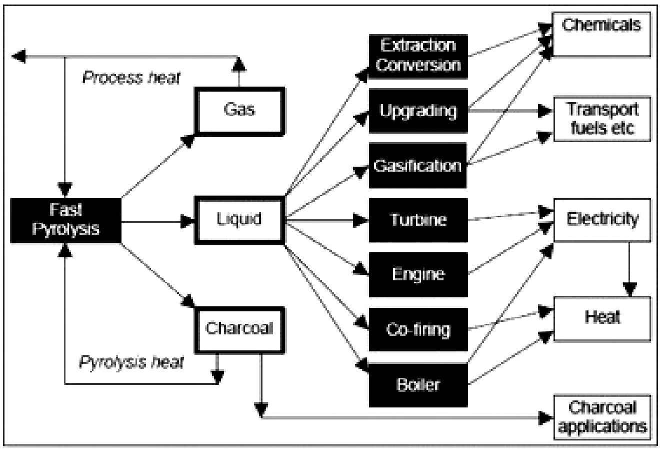

Figure 2.Application of Liquid Bio-Oil.

L. Fagbemi et.al [6] envisaged the pyrolysis of wood, coconut shell and straw in a pyrolysis reactor of 1.20m length and 6 cm diameter. The Pyrolyzer is made up of quartz tube, heated by a cylindrical oven. Experimental results show that higher pyrolysis temperature favored the production of H_2.Also gradual decrease in temperature decreases the CO_2 concentration with an increase in concentration of CO.

For coconut shell an increase in temperature from 500°C to 600°C the H_2 content was reported to be increased from 5.4% to 12.4%.

At an operating temperature of 600°C the content of H_2 reported for coconut shell is 12.4%. This is higher than H_2 composition reported for wood pyrolysis which is only 10.8% at 600°C. [6].

Also increase in temperature above 700°C is found to favor the concentration of CO. The CO concentration for coconut shell is 44.2% and woodchips is 50.2% at 800°C. [6].The H_2 concentration was also found to be higher at 800°C with 23.5% for coconut shell and 20.8% for woodchips. Coconut shell is also found to be an excellent CH_4 generator than the wood. CH_4 concentration was reported to be 23.5% for coconut shell and 20.8% for woodchips at 800°C.

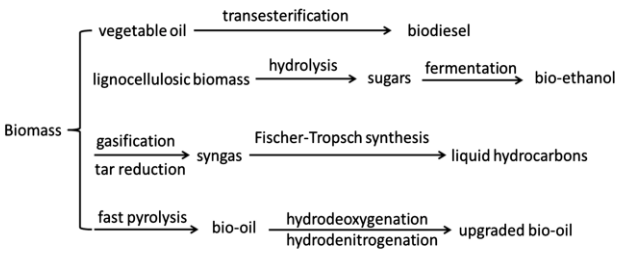

Figure 3.Schematic view of Bioprocess

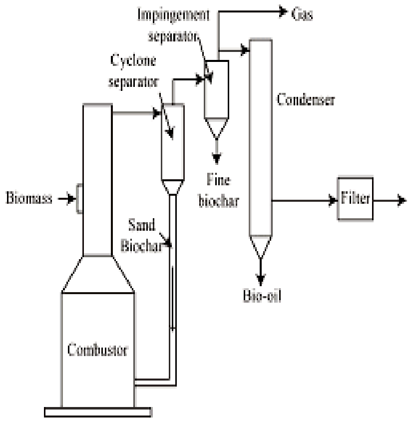

Figure 4.Schematic view CFB Pyrolysis process

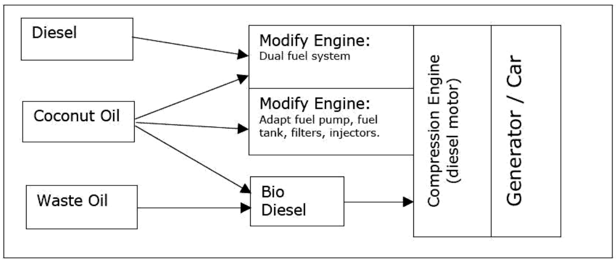

Figure 5.Schematic view CFB Pyrolysis process

III. RESULTS AND DISCUSSIONS

Bio-oil derived from coconut shell has GCV ranging from 15-38 MJ/kg which can be used for combustion in boiler and as an alternate fuel in diesel engine with some modification in engine. At higher temperatures above 500°C thermal cracking of Tars produces a purified syn gas rich in CO and H_2, which can be used as feedstock for combustion in Diesel engines.[6] **.**

V. F. Olontsev et.al [7] investigated that high carbonaceous charcoal can be extracted up on the pyrolysis of coconut shells with particle size of 3–10 mm. The optimum pyrolysis temperature of coconut shell is reported to be 550°C for maximizing the liquid yield with particle sizes ranging from 1.18-1.80 *mm* [2].

The calorific value of the bio-oil is found to be slightly lesser than the diesel fuel. Table 2. Shows the properties of bio-oil obtained under optimum conditions reported by E. Ganapathy Sundaram et.al [2]. Bio-oil flash points found in open literatures are in the range of 40-70 °C or above 100°C, which depends on the volatiles organic content [4].

Table 2. Experimental observations of bio-oil

Properties	**Bio-oil** [2]	**Bio-oil** [4]	**Diesel Fuel** [8] ,[9]
Elemental	(Wt %)		(Wt %)
Carbon	75.4	-	82.5%
Hydrogen	11.7	-	12.75%
Nitrogen	2.4	[illegible]	-
Oxygen	10.5	-	-

Density(kg/m3)	1090	1095.5	860
Viscosity	36 at 50°C (cSt)	1.99 at 50°C (cSt)	4.0 at 30°C (cSt)
Flash Point	80(°C)	>100(°C)	52–96°C
HHV / GCV(MJ/Kg)	38.6	21.4	44 - 45.60

IV. CONCLUSION

The calorific value *of* coconut shell ranges from 20 -23 (MJ/kg). The energy crisis can be compensated by using the abundantly available coconut wastes across villages in India. For Pyrolysis process the most suitable resource is Coconut shell, due to its less content of ash, higher proportion of volatile matter and surplus availability in rural villages all around the year.

The bio-oil yield of the pyrolysis process depends up on the molecular structure of organic matter, the degree of metamorphism, the rate of heating, the removal of volatile substances, and the intensity and time of thermal action.

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ABBREVIATIONS

CO is the % of Carbon Monoxide\\

CO_2 is the % of Carbon Dioxide

CH_4 is the % of Methane

H_2 is the % of Hydrogen

HHV is the Higher Heating Value

LHV is the Lower Heating Value
(or Net Calorific Value)

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