Estimation of Power Generation Capacity of Non Woody Biomass and Coal Biomass Mixed Fuel Samples and Their Energy Values

A Major Project II Submitted in Partial Fulfilment of the requirements for the award of the degree of

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DECLARATION

I hereby declare that the work which being presented in the major thesis entitled **"Estimation of Power Generation Capacity of Non Woody Biomass and Coal Biomass Mixed Fuel Samples and Their Energy Values"** in the partial fulfilment for the award of the degree of Master of Technology in **"Thermal Engineering"** submitted to Delhi Technological University (Formerly Delhi College of Engineering), is an authentic record of my own work carried out under the supervision of **Dr. RAJESH KUMAR,** Department of Mechanical Engineering, Delhi Technological University (Formerly Delhi College of Engineering). I have not submitted the matter of this dissertation for the award of any other Degree or Diploma or any other purpose what so ever. I confirm that I have read and understood 'Plagiarism policy of DTU'.

Place: Delhi **VIVEK HANS**

Date**:** **Roll No. 2K15/THE/20**

CERTIFICATE

This is to certify that VIVEK HANS, (Roll no. 2K15/THE/20), student of M.Tech., THERMAL ENGINEERING, Delhi Technological University, has submitted the dissertation titled **"Estimation of Power Generation Capacity of Non Woody Biomass and Coal Biomass Mixed Fuel Samples and Their Energy Values"** under our guidance towards the partial fulfilment of the requirements for the award of the degree of Master of Technology under our guidance and supervision.

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It is said that gratitude is a virtue. This part is dedicated to special thanks that I would like to deliver to the people who helped me in making the fulfillment of this thesis project possible.

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ABSTRACT

On account of environmental problems and energy with reference to fossil fuels/non renewable resources (coal, petroleum and gas) in the production of power, a greater focus is being given worldwide by technocrats and scientists and researcher for consumption of renewable energy/fossil fuels sources or reusable energy sources in the generation/production of power, metallurgical factories and so further There exists a variety of inexhaustible energy sources out of which biomass is the most financially feasible source for most parts of the world. Biomass is a carbonous material which serves the purpose of not only producing thermal energy but also reduction of oxides, while other inexhaustible energy sources only render to the former. Out of all the solid fuels, biomass is a homogenous fuel containing low levels of ash. According to India's renewable energy sources' power generation potential data, biomass has the capacity to produce higher than 18000 MW of electricity in an year. However, our territory hasn't completely succeeded in the efficient and judicious utilization of Biomass as it could produce merely 2000 MW (approx.) of electricity in a year despite the Indian Government introducing incentives for the same. Therefore, it is imperative to take prudent measures in order for biomass to be utilized in rational terms and extract its benefits in an environment friendly manner. The existing venture work is a supportive venture towards vitality and ecological issues confronting the planet. The currently chosen agro-forestry biomass species have no materialistic use and are less utilized.

Co-firing of biomass fuel and coal has been proven to be an increasingly effective and a pocket friendly technique for the generation of power. For this study, non-cooking coal arranged locally and the related biomass species were mixed in different ratios to make briquettes (coal;biomass = 95.00:05.00, 90.00:10.00, 85.00:15.00, 80.00:20.00). The objective was to evaluate their values of energy and potential to generate power.

The experimental work executed for this thesis has been dealt with in the third chapter which includes ascertaining the proximate analysis, heating value and ash fusion temperature (AFT) of various elements of biomass, non coking coal & their combination.

The study concluded that Biomass species of Cassia Tora have somewhat higher ash contents and low fixed carbon contents along with lower energy values. On the other hand,

Gulmohar biomass species were seen to have comparatively lower ash contents and higher fixed carbon contents while the Energy values were found to be relatively tad higher. The result of the proximate analysis of the chosen and studied coal shows it of F-grade.

Apparently, a rise in the biomass content (nascent branch/wood/leaf) leads to a rise in the values of energy in the resulting briquettes. While considering both Volatile Matter (VM) and Fixed Carbon(FC) results, this gives the idea of the unstable/volatile matter substance impact the vitality estimations of the briquettes alongside settled carbon. Out of the four AFTs (IDT, ST, HT and FT), softening the powder's temperature holds essential significance for the evaporator operation. It has been proven by the results that both the species of biomass have somewhat the same temperature for the purpose of softening but relatively reduced when compared to coal. It was observed that a rise in the content of biomass in the briquette (Coal+Biomass) being studied had trivially lowered the softening temperature which showed that it was safe to operate the boiler up to approximately 1100 ^{0}C.

The establishment procured from this project work is furnished in Chap. 4 of the dissertation.

Keywords: proximate analysis, ash fusion temperature (AFT), energy generation, heat content, non-woody biomass specimen.

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INTRODUCTION

1.1 INTRODUCTION

Sustainable development is essential in developing countries like India and economic development demands energy for every section of the Indian wealth – industry, farming, convey, domestic and commercial which makes it significant for any developing country. Rapid decrease of fossil fuels due to the ever increasing consumption of known reserves is a serious issue in the country as it made the country excessively reliant on fuels like gas, coal and oil. Concerns have been raised about the energy supplies needed to sustain our economic growth because of potential shortages due to rising prices of gas and oil. Environmental problems have also been linked to excessive use of fossil fuels on local and global levels. Evaluating the goodness offered,Biomass has been considered an evergreen source of energy for the country as both, thermal energy and reduction for oxides are taken care of by it. It's renewability, wide availability, carbon-neutrality and the potential to generate employment in rural areas makes it even more desirable. It provides firm energy and approximately 32% of country's overall primary energy consumption continues to be extracted from biomass. Ministry of New and Renewable Energy has initiated a number of initiatives for promoting judicious techniques to use it in several economic sectors to ascertain utmost extraction of its benefits. The industry of Biomass power generation in our country receives investments above Rs.600 crores annually and creates over 5000 million units of power and an annual employment of around 10 million man-days in the rural areas. Biomass power and cogeneration programme has taken up bagasse based cogeneration in sugar mills and biomass power generation for optimum consumption of biomass.

1.2 DIFFERENT RENEWABLE ENERGY SOURCES

Natural processes constantly rejuvenate inexhaustible energy sources. For instance, wind energy, solar energy, bio-energy. Considering the issues in the environment rooting from consuming fossil fuels for generating power, scientific experts worldwide are on the lookout for alternate fossil fuels which can compensate. Some of them include:

- Wind Energy
- Solar Energy
- Hydropower
- Geothermal Energy
- Nuclear Energy
- Biomass and Bio-energy

1.2.1 Biomass and Bio-energy

Biomas is a natural and inexhaustible matter removed from plants, trees, people or from harvest, creature, modern and city squanders and can be sorted into two sorts, non-woody and woody. The former contains agro industrial and agicultural residues and animal, industrial and municipal remains while the latter is extracted from forests, forestry residues and plantations.

It absorbs an equal amount of carbon in order to grow as it gives out when used as a fuel and thus does not release Carbon Dioxide in the atmosphere. It can be used to create power with the use of the equipment that is presently utilized for the purpose of burning fossil fuels and this is its advantage. It is an essential energy source and seconds coal, oil and natural gas worldwide when it comes to fuels. Biomass gives out bio-energy which further gives rise to bio-gas which is considered to be an important energy resource for sustainable global development. A higher energy efficiency is offered by biomass through a configuration of biogas rather than by straight burning. Sun’s stored energy is contained in biomass and this energy is absorbed by plants in a process called Photosythesis. Plants carrying chemical energy pass it on to various creatures including human beings that consume these shrubs. Biomass is replenishable as trees and crops can be re grown and waste is neverending. Crops, manure, wood, garbage are some examples of biomass and when they are burned, the chemical energy comes out in the form of heat. The wood burnt in a fireplace acts as biomass fuel and wood wastage and other refuse can be burnt to generate steam to produce power, or to supply industrial energy.

The only way to release energy is not burning Biomass but also by its conversion to methane, fuels for transportation, such as ethanol and biodiesel and other forms of usable energy. The main ingredient of natural gas is methane and is emitted from rotting garbage, human and agro waste. It is also known as “biogas” or “landfill gas”. Ethanol, a transportation fuel, can be produced through the fermentation of corn and sugarcane while leftover food products like animal fats and vegetable oils produce biodiesel. Approximately 3% of the energy consumed in USA (United States of America) is supplied by Biomass fuels. The residents of the US aim to give rise to techniques to burn less fossil fuels and more of biomass so that waste can be cut back on to help agricultural products grown there as it has several environmental advantages.

1.3 POWER GENERATION POTENTIAL FROM BIOMASS AND BAGASSE BASED COGENERATION

The most sustainable and probably the worlds biggest energy sources for production of power in the 21st century are Biomass Resources (*Rao-and-Hall,1999*). The estimated accessibilty of Biomass in our country is currently 500.00 million metric tones per year approximately. A surplus biomass of around 120-150 million metric tonnes annually has been estimated by a study sponsored by the ministry which could support forestry and agricultural remnant corresponding to a capacity of around 18,000.00 MW. Besides, an additional electricity of around 5000 MW could be created with the use of cogeneration based on bagasse in the 550 sugar mills in the country on adopting economically and technically utmost amounts of cogeneration of deriving electricity from the bagase produced (MNRE Ministry of New and Renewable Energy). Further information about cumulative power creation and renewable energy capacity have been given in Table 1.1 showing that the present amounts of biomass hold the capacity to produce about 18,000 MW of power. (MNRE,2016)

Biomass power co generation initiatives have been implemented by the Ministry since mid nineties. In order to supply electricity to a grid holding 130 biomass power initiatives approximating to 158 bagassee cogeneration projects and 999.0 MW in sugar mills with surplus potential with 1666.0, 228 biomass and cogeneration power programmes with 2665 MW potential have been introduced in India. Also, various stages of implementation of about 30 biomass power initiatives approximating to around 350 MW are being carried out. Approximately 70 cogeneration programmes with surplus potential of about 800 MW are under the stage of implementation. Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu and

Andhra Pradesh have taken the position of leadership in the carrying out of bagasse cogeneration programmes while Andhra Pradesh, Chhattisgarh, Maharashtra, Madhya Pradesh, Gujarat and Tamil Nadu are the states in biomass power initiatives. (http:///mnre.gov.in/prog-biomasspower.htm).

Tab1.1: Energy Production Capacities of Inexhaustible Energy Resources in India

Ministry of New & Renewable Energy			
Programme/ Scheme wise Physical Progress in 2016-17 & cumulative up to the month of March, 2017			
Sector	FY- 2016-17		Cumulative Achievements
	Target	Achievement (April - March, 2017)	(as-on 31.03.2017)
I.GRID-INTERACTIVE POWER (CAPACITIES IN MW)			
Wind-Power	4000.50	5502.38	32279.77
Solar Power	12000.00	5525.98	12288.83
Small Hydro Power	250.50	105.95	4379.90
BioPower (Biomass & Gasification and Bagasse Cogeneration)	**400.50**	**161.95**	**8181.70**
Waste-to-Power	10.00	24.00	115.00
Aggregate	**16661.50**	**11320.26**	**57245.23**

Source: MNRE Data toward the finish of March, 2016

Ministry of New & Renewable Energy			
Programme//Scheme wise Physical Progress in 2016-2017 & cumulative up to the month of March, 2017			
Sector	FY- 2016-17		Cumulative Achievements
	Target	Achievement (April - March, 2017)	(as on 31.03.2017)
II.OFF-GRID/ CAPTIVE POWER (CAPACITIES IN $MW_{EQ)}$			
Waste to Energy	15.00	12.21	171.09
Biomass(non-bagasse)Cogeneration	60.00	0.00	651.91
Biomass-Gasifiers	10.00	2.80	161.45
AeroGenrators/Hybrid systems	1.00	0.46	3.15
SPV-Systems	100.00	155.51	462.54
Water mills/small hydel	1 MW + 500 Water Mills	0.10 MW + 100 Water Mills	18.81
Aggregate	**187.00**	**171.07**	**1468.95**
III.OTHER RENEWABLE ENERGY SYSTEMS			
Family Biogas Plants (in Lakhs)	1.00	0.48	49.56

Source: MNRE Data toward the finish of March, 2016

Table 1.2: State-wise/Year-wise List of Commissioned Biomass Power/Cogeneration Projects in MW (as on 01.04.2016)

SNo.	States	Till 31-03-2012	2012-13	2013-14	2014-15	2015-16	Grand Aggregate
1	Andhra Pradesh	363.250	17.50	--	--	--	380.750
2	Bihar	15.50	27.920	--	--	--	43.420
3	Chattisgarh	249.50	--	15.00	15.00	--	279.90
4	Gujarat	20.50	10.00	13.40	12.40	--	56.30
5	Haryana	35.80	9.50	--	--	--	45.30
6	Karnataka	441.180	50.00	112.00	111.00	158.00	872.180
7	Madhya Pradesh	8.50	7.50	10.00	9.00	--	35.00
8	Maharashtra	603.70	151.20	185.50	184.00	96.38	1220.780
9	Odisha	20.00	--	--	--	--	20.00
10	Punjab	90.50	34.00	16.00	15.00	--	155.50
11	Rajasthan	83.30	10.00	8.00	7.00	--	108.30
12	Tamil Nadu	532.70	6.00	32.60	31.60	39.00	626.90
13	Uttarakhand	10.00	--	20.00	20.00	13.00	50.00
14	Uttar Pradesh	644.50	132.00	--	--	93.50	842.00
15	West Bengal	16.00	10.00	--	--	--	26.00
	Total	**3135.3300**	**465.6000**	**412.5000**	**405.0000**	**400.0000**	**4831.3300**

Source: MNRE Data toward the finish of March, 2016

1.4 BIOMASS: CLASSIFICATION AND PROPERTIES

On the premise of normal frame and its accessibility, biomass assets can be grouped into two sorts.

1.4.1 Woody-Biomass and Non-woody-Biomass

- **Woody-Biomass**

High calorific value, low moisture, less void age, less ash content and high bulk density characterize the Woody Biomass. The cost of woody biomass is higher and its supply is lower due to its vast advantages which makes it preferable in devices which convert biomass to energy but its cost and accessibility are its shortcomings.

- **Non-woody biomass**

Non woody biomass contains poultry operations, manure from confined livestock, organic fraction from solid municipal wastes, residues from agricultural crop remains post harvest and is determined by lower calorific value, raised moisture content, high ash content, high void age and reduced bulk density. It has several shortcomings which makes it very cheap and sometimes places it in negatives.

1.4.2 Biomass properties

Evaluation of Biomass' utility in chemical feed stocks requires and understanding of it properties and structure. The gasification of Biomass includes a study of its heat capacities and transport properties, physical structure, heats of formation and combustion, chemical analysis.

- **Bulk chemical analysis**

It is advisable to have combustion heats, ash analysis, proximate and ultimate analysis in the evaluation of gasification of feed stocks which give us details on heat content and elemental composition, feedstocks volatility. The evaluation of the feedstock with respect to potential pollution demandes elemental analysis. In comparison to fossil fuels like coal, oil and gas, Biomass is less preferred because of it lo energy density.

➢ Physical properties

True density and apparent particle density, diffusion coefficient and densities viz. bulk density, heat capacity, thermal conductivity, void age, size and shape are the major physical details significant for prediction of pyrolysis effect on biomass(thermal action), gasification and burning. Different biomass' have different values, especially loose biomass.

➢ Biochemical analysis

In order to break the molecules which make up the biomass, several efficiently functioning biochemical processes have been introduced owing to its natural status and many of these biochemical translation techniques can be mobilised. The breaking down of biomass takes place by using the enzymes of micro-organisms like bacteria through biochemical conversion. Anaerobic digestion, Fermentation and Composting are some processes used by micro-organisms to perform the conversion process in most cases.

1.5 BIO-ENERGY TECHNOLOGIES FOR DECENTRALIZED POWER GENERATION

The approach in bio energy technologies (BETs) in the past couple of decades have empowered a noteworthy increment in usage of biomass for energy production. Important innovations available for advancing energy production from biomass in our country are gasification, consuming, cofiring (consuming of two fuels) and bio-mutation.

1.5.1 Gasification

Devices that promote the conversion of thermo chemical biomass to high grade energy inflammable gas for using in gas turbines by oxidation and reduction under sub stoichoimetric conditions are called Biomass Gasifiers. In order to be able to use in ICE (internal combustion engines) for electrical purposes and mechanical uses, conversion of biomass, specially woody biomass, into high grade energy combustible gas is necessary. Depending on the direction of air flow, Gasifiers can be categorized into updraft, downdraft and crossdraft. Systems of Gasifiers with capacities of 1.00 kg per hour to upto 500.00 kg per hour are currently employed which help in the generation of power through engines that reciprocate and for direct utilization in heat applications. Diesel engines connected to alternators are the prime movers wherein the diesel saves up to 80% of the fuel. These frameworks are utilized to fulfill both power production utilizing reciprocating engines or for straight away use in thermal application. The prime movers are diesel motors associated with alternators, where diesel fuel saving up to 80.00% are conceivable. Small scale gasifiers with the capacity to fulfill the rural power requirements (20–500 kW) and leave a enormous for feeding the national network are among the biomass power options. As of 2017, approximately 4760 Mw is the total installed potential of biomass gasifier systems. Likewise, around 30 biomass power ventures amassing to around 350 MW are under different phases of implementation. Around 70 Co-generation activities are under usage with surplus limit collecting to 800 MW. States which have taken authority position in usage of bagasse cogeneration activities are Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Uttar Pradesh. The main States for biomass control tasks are Andhra Pradesh, Chattisgarh, Maharashtra, Madhya Pradesh, Gujarat and Tamil Nadu.

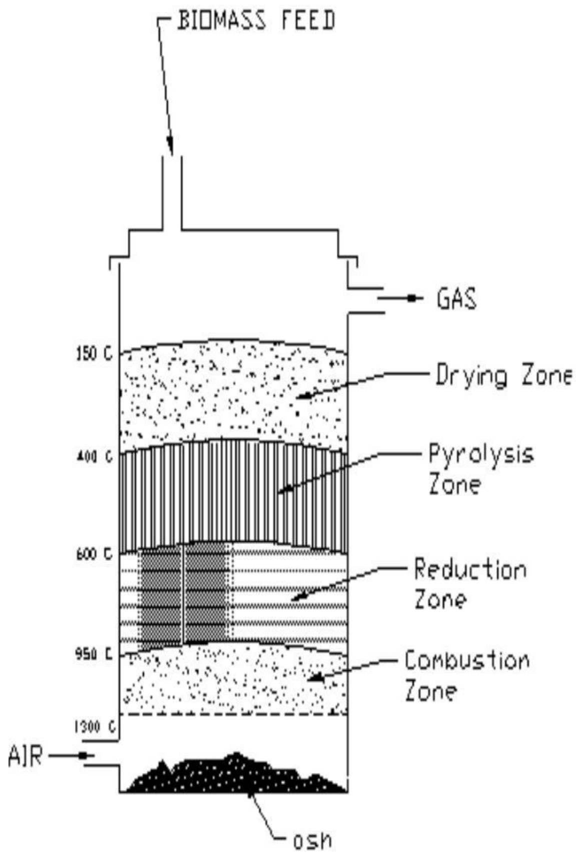


Figure1.1: Updraft-Gasifier

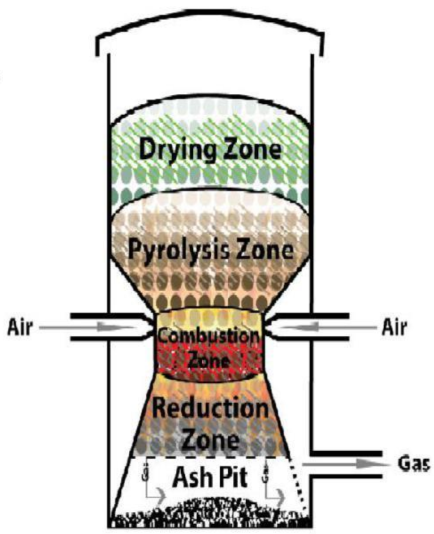


Figure1.2: Downdraft-Gasifier

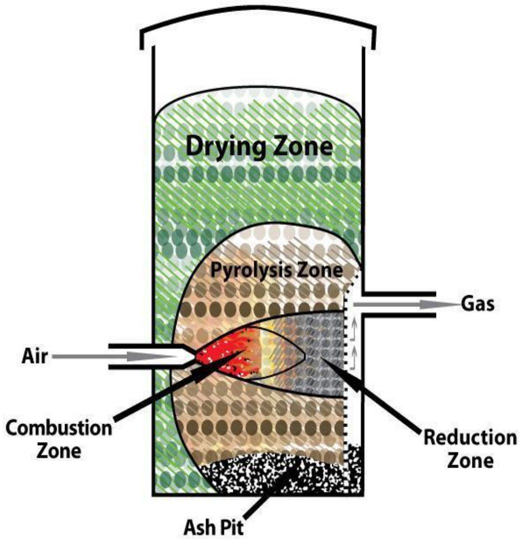


Figure1.3: Crossdraft-Gasifier

When the fuel enters into the gasifier, following four processes take place:

a) Dehydration of fuel

b) Pyrolysis

c) Combustion – burning of fuel

d) Reduction of fuel

➢ Drying of fuel

This is the first stage. As 7-15% of the air dried biomass is moisture, the upper most layer of moisture content is separated by evaporation through heat radiating from oxidation zone where the temperature is lesser than 120 °C.

➢ Pyrolysis

The loss of biomass volatiles in air presence and its conversion to char is known as Pyrolysis. The volatiles are lost at a temperature over 200 C and this continues while the biomass travels towards the oxidation zone and as the temperature reaches 400°C, the woods natural structure breaks down due to a self sustained exothermic reaction and water vapours, char, acetic acid, methanol and large amounts of heavy HC(hydrocarbon) tars are the outcomes.

- **Combustion**

A solid fuels combustible substance is composed of oxygen, hydrogen and carbon. The carbon content in the fuel provides carbon dioxide and the water is obtained in the form of steam from hydrogen for the process of complete combustion to take place which is a exothermic reaction and produces a theoretical oxidation temperature of 1400 °C. The prime reactions, therefore, are:

$$C + O_2 = CO_2 \text{ (+ 393 MJ/kg mole)} \quad (1)$$

$$2H_2 + O_2 = 2H_2O \text{ (- 242 MJ/kg mole)} \quad (2)$$

- **Reduction:**

Water, CO_2(Carbon dioxide) and the products obtained from pyrolysis which are partially un-combusted are products of partial combustion which pass via a hot charcoal bed where the following processes of reduction happen:

$$C + CO_2 = 2CO \text{ (- 164.9 MJ/kg mole)} \quad (3)$$

$$C + H_2O = CO + H_2 \text{ (- 122.6 MJ/kg mole)} \quad (4)$$

$$CO + H_2O = CO + H_2 \text{ (+ 42 MJ/kg mole)} \quad (5)$$

$$C + 2H_2 = CH_4 \text{ (+ 75 MJ/kg mole)} \quad (6)$$

$$CO_2 + H_2 = CO + H_2O \text{ (- 42.3 MJ/kg mole)} \quad (7)$$

The main reduction reactions are reactions (3) and (4) as they are endothermic and have the capacity to reduce the temperature of the gas because of which the reduction zone temperature is restricted to 800-10,000 C. Lesser the temperature of the reduction zone, lesser is the gas' calorific value (700- 8000C).

1.5.2 Combustion: Steam Turbine System

The thermal power production technology and the combustion technology are similar to one another wherein a turbine is driven to generate power by burning the biomass in the boiler to produce steam. With just about 466 MW installed by 2007, the number of biomass based combustion systems are less. In comparison to coal-fired plants, the capacity of these plants is about 10 timessmaller from 1.00 to 100.00MW due to high transportation costs and unavailability of local feedstock. A limited number of thermal or CHP(is nearby power generation that catches the heat that would some way or another be squandered to give valuable thermal energy, for example, steam or high temp water—that can be utilized for space heating, cooling, local heated water and mechanical procedures) large scale plants are in operation. The investment cost is approximately doubled resulting in lesser electrical effectiveness because of the small size of the plant in comparison to coal plants and the plant size accounts for around 30.00% accountability. The above mentioned process also helps in eliminating and in the disposal of wastes and residues in large amounts. Bio energy production with forest and horticultural items use fossil energy at a rate as low as 2.00-5.00% of the obtained energy. Utilizing top quality wood contributes in today's consolidated heat and power (CHP) plants with most elevated steam temperature of 540.00°C, electrical effectiveness can achieve 32.00%-34.00% (LHV) & upto 42.00% when worked in power method. The emissions of final carbon per unit-area is lesser than 10.00% of the fossil fuel based electricity emissions, according to life cycle assessment. The steam temperature is limited by corrosion problems and the electricity efficiency is decreased to about 25% while using MSW. An electrical efficiency of 25%-30% and an overall efficiency of above 80%-90% is expected to be reached in the new CHP plant designs using MSW if the heat generation meets the demand. The power production using MSW saves a total emission of between 726.00 and 1525.00 kg CO_2/ MSW and also, CHP involves a higher reduction rate.

1.5.3 Co-Firing

Biogas will be made by changing biomass either by slow anaerobic fermentation that converts concerning 50.00%-60.00% of feed-stock with oil conditioners as a by product or by quick thermo chemical processes with biogas and alternative fuels as a product with concerning 2%-4% of ash. With concerning 30-35% proficiency, it will beemployed in combustion engines, at higher efficiencies in gas turbines or in combined cycles that are extremely economical. Biomass incorporated gasification gas turbines

(BIG/GT) are not nevertheless in modern industrial usage, however its financial science is foreseen to support. the essential incorporated gasification consolidated cycle (IGCC) running on 100.00% biomass (straw) has been with success worked in Sweden. IGCC plants are as of now financially focused in CHP mode abusing dark alcohol from the mash and paper exchange as a feedstock. diverse improvements have brought Stirling motors and Organic-Rankine-cycles (ORC) near the market though coordinated gasification energy unit or electric cell plants (IGFC) still need impressively extra research and developments.

Focal points of cofiring the ignition of2 varying sorts of matter at a comparable stretch. One among the advantages of co-terminating is that a current plant will be accustomed to consume a substitution fuel, that can be less expensive or additional ecologically well disposed. For instance, biomass is typically co-fired in an already setup coal plants as opposed to newly setup biomass plants. Co-firing may likewise be set up to refine the ignition of fuels with low energy content. For instance, swamp(lowland)gas contain an outsized quantity of greenhouse gas depleting substance, that is non-ignitable. On the off chance that the swamp gas is scorched while not evacuating the ozone harming substance, the contraption won't not perform legitimately or discharges of contaminations may increment. Consuming it with flammable gas will grow the heat substance of the fuel and redesigns ignition/consuming and mechanical assembly limit. For whatever length of time that the power or energy yielded from the biomass and swamp gas was generally going to be made with non-inexhaustible energizes, the focal points are fundamentally proportionate regardless of whether they are co-fired or combusted alone. Likewise, co-firing might be acclimated to bring down the discharge of a few contaminations. for instance, cofiring biomass alongwith coal prompts smaller quantity of sulfur outflows as compared to consuming coal without anyone else's input.

Two particular systems are out there to cofire bio-energizes in utility boiler:

(i) Straight away cofiring, biomass fuels are mixed with coal in coal plants and furthermore the mixture is circulated to the firing systems framework Fig.1.4 and

(ii) Indirect cofiring, the biomass is produced one by one from the coal and infused into the kettle/boiler while not affecting the coal conveyance technique Figure.1.5. The essential beginning, when all is said in done, is utilized with however 5.00 weight percentage co-firing.

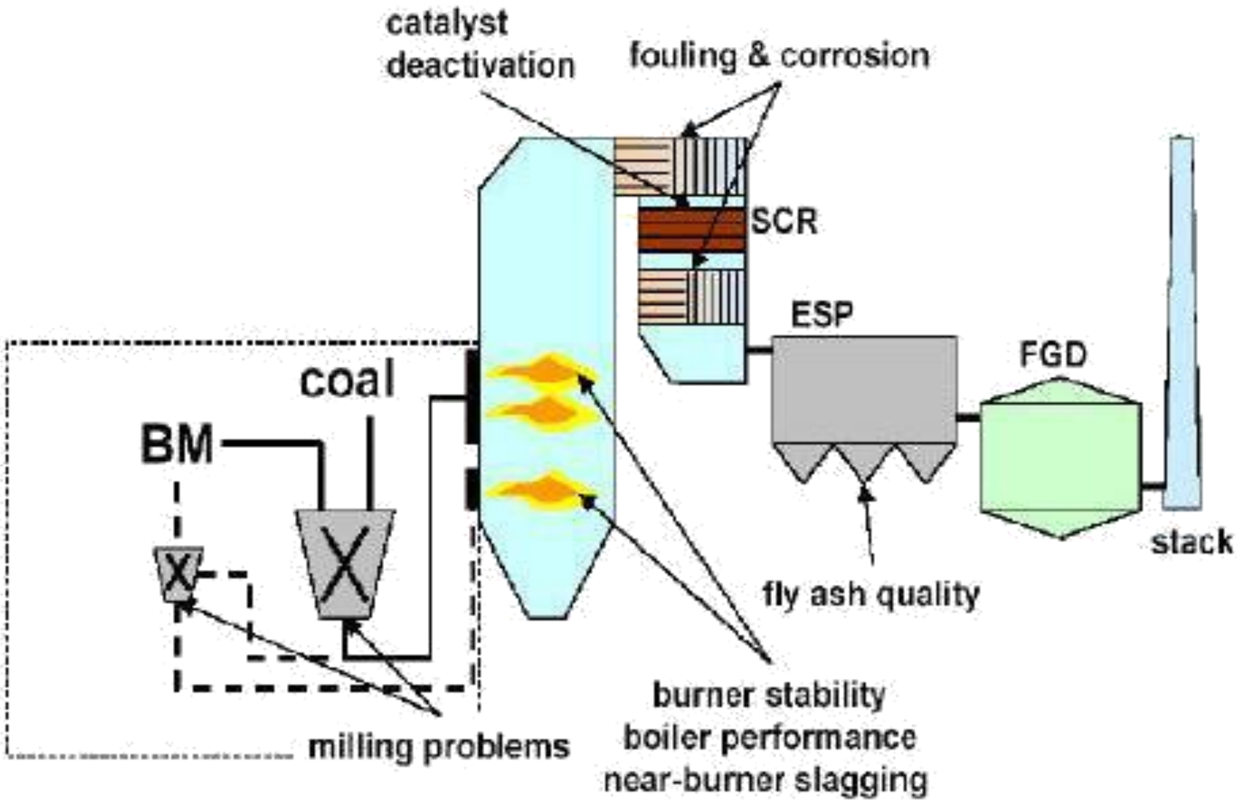


Figure.1.4: Direct Cofiring Mechanism

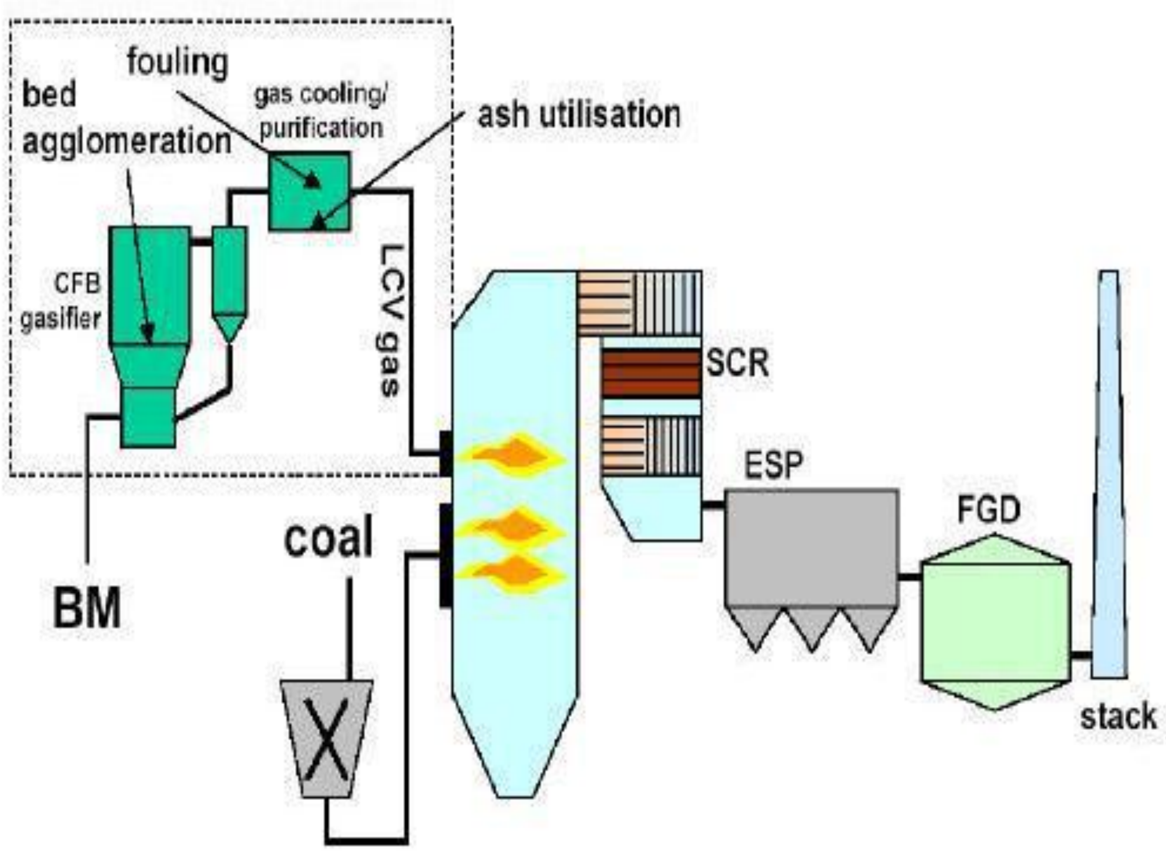


Figure1.5: Indirect Cofiring Mechanism

1.5.4 Bio-methanation

The innovation of biogas (a blend 60.00% CH_4 arrangement & 40.00% (CO_2) gas) creation through an-aerobic (absence of free oxygen) fermentation of cellulosic materials, similar to creature excrement, plant and vegetable squanders, and so on (Ravindranath and Balachandra, 2009) and ignition of thes gas for power production. The an-aerobic assimilation of wastage has the inconveniences of immense establishment value, longer reaction time, higher quantity of water demands and huge space for putting in the plant. Aside from some exhibit ventures, scarcely any potential has been exploited up to this point in India.

1.6 FEEDSTOCK & PROCESSES

Biomass assets includes woodynon-woody and creature compost, deposits comingfrom sustenance and paper businesses, farming buildups, wood-squanders comingfrom trade and forest services, municipality dispatch, sewerage ooze, sugarcrops , devoted energy plants like shortrotation (5-15 years) vegetation (sallows, eucalypts, aspen), grasses(silvergrass), oil-crops (soybeans, sun-flower, oil-seed rape, jatropha, palmoil) and starch-crops (wheat). Deposits & natural squander are the important biomass resources to date, however energycrops are a success significance & piece of the pie. With replanting, biomass burning could be a carbon-unbiased strategy in light of the fact that the CO_2 transmitted has to that point been consumed bythe plants present in the environment. Buildups, squander, mash ar fundamentally utilized for energy production. Starchsugar, and oil harvests are basically utilized for fuel creation. Modest, goodquality biomass (for instance., wood wastes) for energy generation might end up noticeably restricted since it may also be utilized for energy creation and in papertrade & mash industries. Modern assets in view of heat harvests have bigger potential however are exceptionally costly. Innovations and estimation of energy production from biomass are based upon accessibility to the feedstock quality, and value for its transporatation, powerhouse measure, change into biogas (assuming any). On the off chance that sufficient biomass is obtainable, biopower and CHPplants are a perfect & solid energy supply proper for base-stack benefit.

Figure1.6 present the various feedstockand various sorts of processes for heat&power production from biomass.

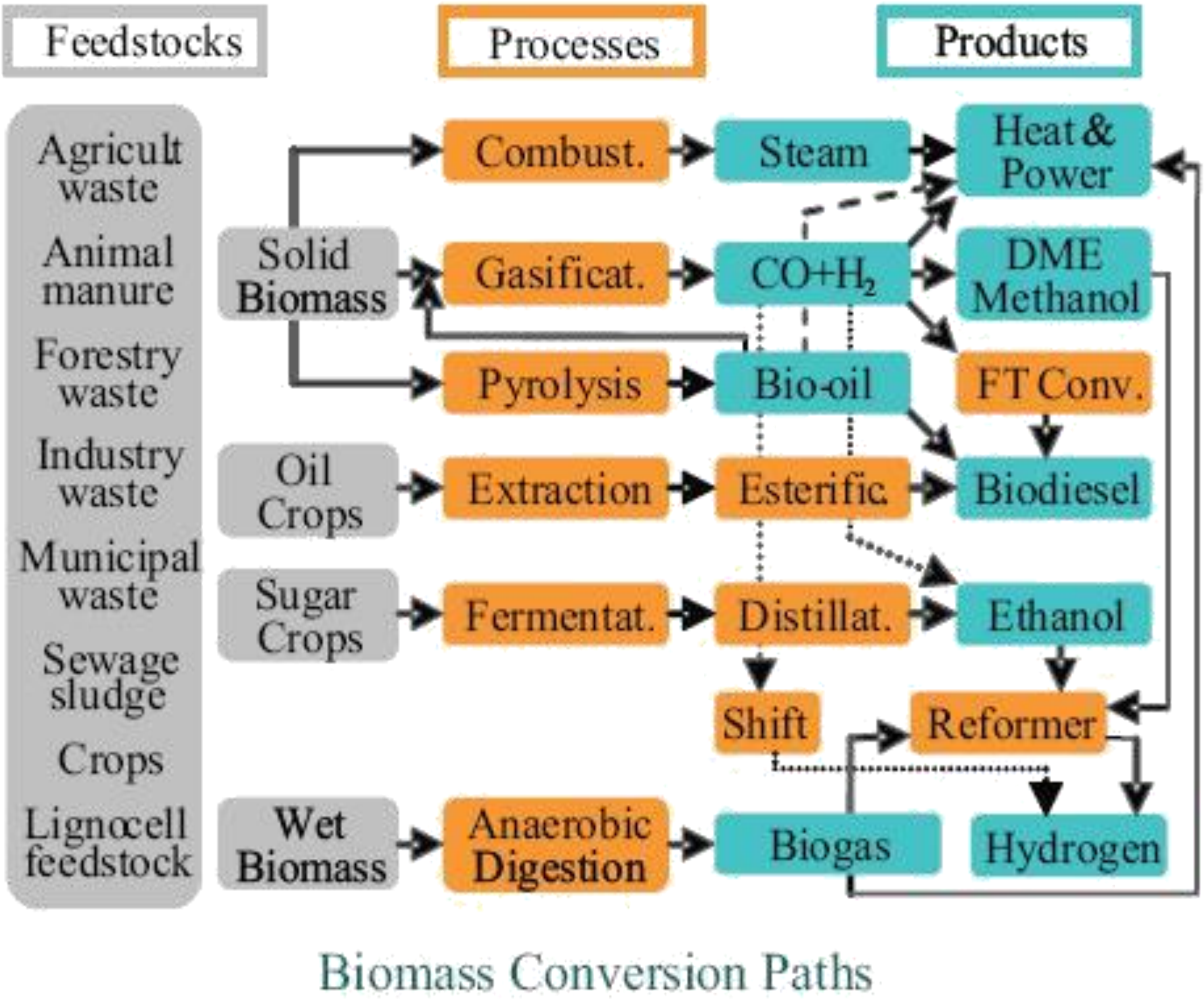


Figure1.6: Feedstock&Processes

1.7 BIOMASS-A SOURCE OF POWER GENERATION IN SMALL SCALE INDUSTRIES

The huge estimation of grant, that's for the most part eccentric and inconsistent because of customary/constrained powercuts, drivesventures to hypothesize restricted energy production. Aswe know exhaustible products are confined & dirtying, such request gives a stunning stage to sustainable for giving totally extraordinary energy answers for altogether little and medium undertakings, modern and business foundations. Biomass energy frameworks might be used to satisfy control request in ventures. Such power production can encourage ventures in transforming into free and mitigate weight on non-renewable energy sources.

The hostage biomass-based energy plants having ability beginning from concerning a hundred kilowatt to few Mega Watt are regularly set-up by a mechanical unit. By and large, ignition based frameworks are suited to Mega Watt-scale enterprises, while gasifiers are adequate for little and de-centralised energy undertaking up to 1.00 Mega Watt control potential. Moreover to power, the biopower plant is additionally conceivable to supply actuated carbon (an important item) that further counter balances the working estimation of the plant.

Under an expansive country improvement strategy, the ascent in yield assorted qualities like rural efficiency, crop differing qualities and in this way the era of rustic monetary benefit and business are given high attention in several developing nations. Advancing and rising country enterprises, naturally, is an essential methodology for accomplishing such approach goals. The majority of smaller enterprises are in suburban & provincial regions. For combustible, greater part is still obtained from wood and farming deposits. conventional| normal|the standard} forms in little scale enterprises are regularly customary and work underneath to a great degree focused conditions. They have to contend with each comparative scale makers besides as bigger scale makers utilizing a great deal of popular and in fact propelled creation offices. they're relatively separated from the supply of aptitudes, capacity and innovation that may empower upgrades in their operations, vitality, and so forth Furthermore, the appallingly nature and situation of the little enterprises typically fortify their seclusion from formal wellsprings of money related, specialized and elective offer assistance. However, little enterprises are perceived to claim imperative part inside the development and steadiness of national, provincial economies and accordingly the survival of subsistent economies. This part gives monetary profit or potentially local work to a few people. It has also been discovered that biomass vitality by and large creates ten folds greater work than oil&coal (deCastro et.Al.,1999).For growing nations, usage of biomassenergy resources may conjointly curtail reliance on outside energysources (deCastro etal.,1999).It's moreover genuine that lack of powers, in assortments of fuelwood & option biomass are undermining maintainability of little businesses. As instance, many cases in Cambodia of minor ventures closing due to deficiencyof fuel (WeNetCam,2000). It had been additionally supposed that a few ranges in Nepal where little enterprises were engaged, experienced ecological corruption in view of fuelwood removal for modern workings (DonovaninBEST.1989).Hence, innovations would help them in increasing respective intensity & yield, redress study&documentation of business range is a fundamental stride now.

Gasification-based little standard biomass frameworks are ascending as a reliable innovation to create power and thermal energy to country ranges, organizations and along these lines the trillion of masses who exist lacking energy around the world. BiomassProgram bolster throughsubcontracted endeavors accompanied with non-public area corporations in past numerous year, hasprogressed numerous renditions ofthe innovation tothe reason where theyare as of today moving toward commercialisation via embracing uniform standard outline, these 5.00 kiloWatt -to- 5.00 MegaWatt frameworks are relied upon to loan themselve to huge quantity delivering procedures that carry themon an aggressive levelwith enormous independent crops. utilizing provincially realistic biomass energizes like wood, harvest wastes, creature composts and landfill gas, little lstandard frameworks can be delivered to the supply of fuel as opposed to torment transportation costs to convey biomass powers to a larger than average halfway arranged plant. Little standard biomass frameworks furthermore satisfy the great market potential for conveyed, nearby, electrical power and thermal generation all through the globe. Little measured biomass frameworks more often than not change over a strong biomass fuel intoa vaporized fuel througha strategy known as gasification. The rising gasvapour, contained essentially of (CO) and (H), is washed down prior usage in gasturbine or interior ignition/consuming engine-associated with an electrical generator. Squander energy from rotary engine may likewise caught & coordinated accommodating applications. Minor standard frameworks loan self to such consolidated thermal and energy methods far superior to enormous focal provisions.

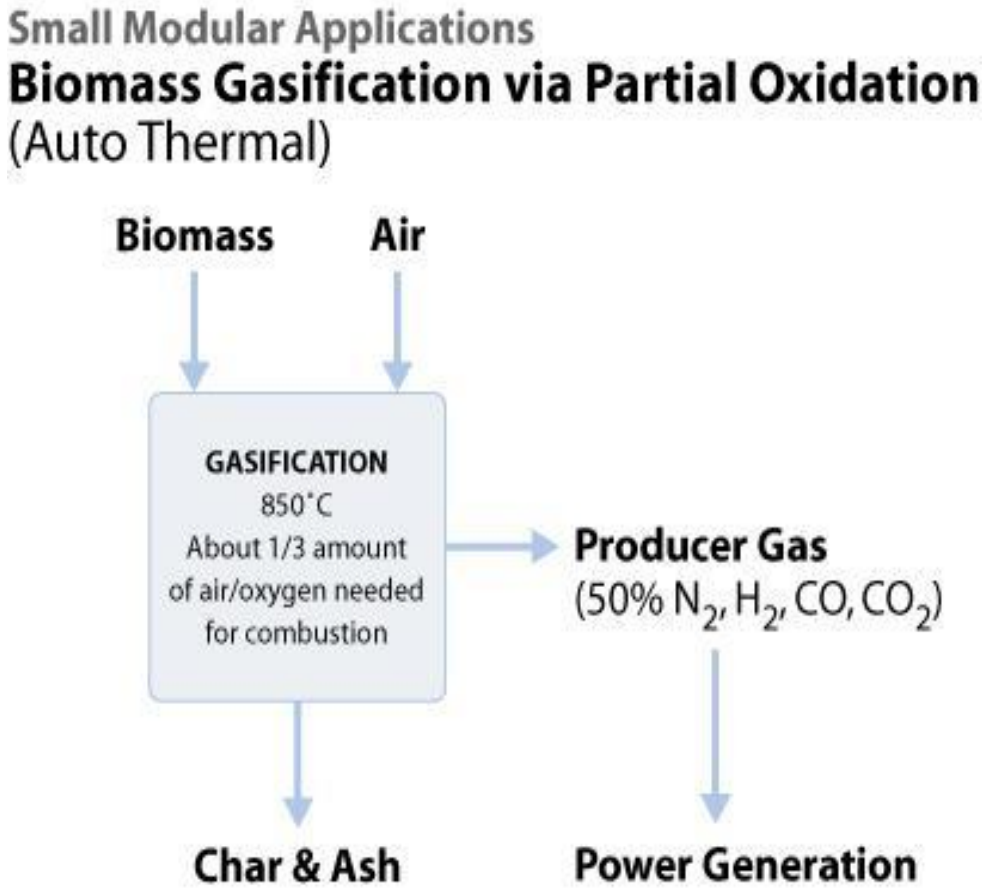


Figure1.7: Small Modern Uses

Small standard biomass frameworks supply a few points of interest to potential clients. They have reduced natural effect when put alongside alternative existing innovations utilizing non coking coal or biomass as fuel. From one perspective, financial matters can be appealing when house proprietors interface the unit to a power network that may get un-used power. On the inverse, modest secluded frameworks will energize disconnected regions forwhich the estimation of relationship tothe matrix is prohibitory. Second financial advantage could likewise expert if the consumer fuses a biomass squander stream which will recover into a supply of heat as opposed to be a monetary weight. The flexibleness to utilize a number of fuel also requests to a few clients. Present day microchip administration has been coupled to gasification innovation to prompt frameworks requiring slightest administrator consideration. What's more, in off-grid areas tiny measured biomass frameworks supply the potentialfor lights, refrigeration, thermal and energy to sanction little bungalow businesses to end up plainly monetarily feasible

1.8 BIOMASS-ENVIRONMENTAL AND CLIMATE CHANGE BENEFITS

In the course of recent years, people all through the globe turned out to be extensively receptive to the terms 'an Earth-wide temperature boost' and greeh-house gasses'. This ought to do with what's going into the air and the {way} it influences our lifestyle. When exhaustible fuel derivatives are ignited they give (CO_2), (SO_x), nitrous oxide (NO_x) emanations & fiery remains creation intothe environment. It's trusted thatthese emanations stays therefor a number of decades and making an obstruction, that isolates the world &sun. Lessening the risk to the air is one among the habitat favorable circumstances of Biomass.

Air space Pollution might be noteworthy test visaged bythe globe these days & effects entire individuals inside various alternative ways. Altogether, our capacity to successfully deliver contamination is vital to our quest for advancing supported monetary process and reasonable improvement. Our reach in trading with contamination concern is, in this manner, raise round the vast need concurred by growing nations tomonetary process & destitution wipeout. The conclusion with respect to battle anti climate contamination be target-hunting by the intelligence that financial improvement, civic advancement & natural security are commonly advantageous and correspondingly fortifying components of supportable advancement.

Poluution has genuine terrible effects on human wellness, financial advancement, eco-systems and social legacy. Firm and capable moves are, subsequently, required in connection to each indoor contamination from notable biomass cooking and warming and encompassing toxins from all advantages. Indoor pollutants, we agree with, ought to be accorded with excessive priority, because of the reality it is in its most exceedingly terrible sort, a neediness related appearance.

Contamination is moreover swelled by variables, for example, catastrophic events together with volcanic emissions, dust storms, geographical process (desertification) and land corruption, that cause medical problems and upset people groups' day by day lives.

Ecologically, biomass has a few advantages over non-renewable energy sources like coal and unrefined petroleum (oil). Biomass consists next to no sulfur and nitrogen (N), accordingly it doesn't produce the poisons that cause corrosive rain. Developing plants to be utilized as biomass energizes can likewise encourage monitor an unnatural weather change. That is therefore of plants expel CO_2greenhouse gasses.from the air after they develop. The burning (immediate or roundabout) of biomass asa fuel moreover gives carbon dioxide to the air. But, this C is a segment in the present carboncycle: it had been consumed all through the development of the plant over the past couple of months or years and, gave the land keeps on supporting developing plant material, an economical adjust is kept up b/w C produced & assimilated. Biomass iswithout much free of sulfur, (N) & critical metals(mercury, and so on.) and is a great deal of lower fiery remains content (1.00-3.00 weight percentage) than coal (Kumar and Gupta, 1993). Subsequently, as opposed to non-renewable energy sources, biomass use in power generation isn't apparently to contaminate the climate with SOx, NOx, SPM, and so forth.

Trees inside the energy manor develop, they ingest carbon dioxide (CO_2) from the environment. Because of fact the wood enscorched at the glow or heat energy creating carbon safeguard in the woodytissue consolidates with gas 2 convey CO_2, this can be discharged tothe biological community in the fumes gasses.

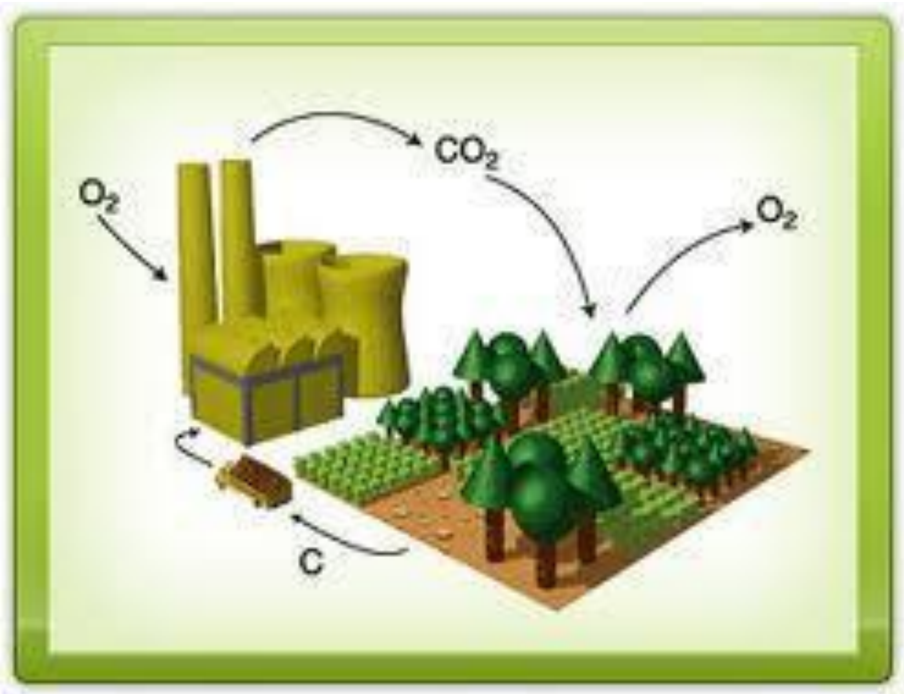


Fig. 1.8: Carbon Cycle Diagram

The amountof extra biomassthat becomes through the span of years in a limited area is comprehended asthe yearly augmentation. Given the quantity expended isa littler sum thanthe yearly augmentation itis utilization might be feasible&biomass might be thought of a lowC fuel&biomass carbon dioxide retention&outflow isin adjust.

1.9 ADVANTAGES OF DECENTRALIZED BIOMASS POWER GENERATION SYSTEMS

- The bio-massbased decentralised energy production frameworks are relied upon to supply the accompanying various communal, financial and natural points of interest to the town individuals:

- Electricityfor lights & improvement of littlescale enterprises, thusmaking the villagers/smallventures own-based.

- Increase in biomasshappens throughphotosynthesis response. Here, thebiomass retains CO_2 fromthe ecosystem & releases O_2. Subsequently the maintainable innovation & utilization of biomass in powerplants will just help with lessening CO_2 fixation inthe climate & accordingly the greenhouse impact.

In assessment tocoal, the fieryash remains contentin biomass might be particularly lower(2.00-6.00% approx. As contrary to20.00-50.00% incoal). In this way, theutilization of biomass inpower production willcause boundless decline in the measure of suspended particulate subjects inside the environment.

- Energy contented in biomass is additional thanthose of E&F review coals(principally mis-used coalsinIndian qualityplants).

- Reactivity ofbiomass toward O_2& CO_2 is significantly superior tocoal. This allows the operationof boiler atlower temperatures bringing about all the more decrease of power.

- Power innovation on decentralised establishment will diminish the transmission misfortunes.

- Practicality of set up of biomass gasifiers in any territory or town

- Esy acessibility of generation and reinforcement structures

- Suport for the home and commercial squander control activities.

- Instead of the above focal points, the rate at which the biomass based energy production is less because of a number of policies, financial & monetary hindrances.

- Utilization of biomass in energy production will prompt better usage of desolate grounds of India(67.00 millionhectaresapprox.)

- In arranging the energy production frombiomass ondecentralised premise, the accompanying focuses ought to be considered:

- Kind, quality, amount, practicality of transportation and capacity, manageability and cost of biomass to be utilized.

- Level of client request.

- Procedure and expenditure on biomass drying.

- Method of power generation and its monetary suitability.

- Costs and characteristics of locally accessible exhaustible products and exhaustible fuels.

1.10 AIMS AND OBJECTIVES OF THE PRESENT PROJECT WORK

Below given arethe aspirations & objectives ofthe present research:

- Choosing nonwoody biomass specimen and approximation in their contribution by fieldtrial.

- Calculation of proximateexamination (percentagemoisture, percentage volatile matter, percentage ash/debris content& percentage fixedcarbon substance) in their selective segments, together with wooden, leaf and early branch.

- Mix these biomass parts one after the other with coal sample in stand-out elite proportion.

- Characterisation of those biomass parts for their electricity value (calorific esteems).
- Characterisation of coal combined biomass parts for their energycontent (heating value).

- Finding A.F.T (I.D.T, S.T, H.T & F.T) of slag acquired from those biomass specimen & coalbiomass blended mixtures.

- Approximation of energy production possibilities of these biomassspecimen for a little warm powerplant on decentralised premise.

- Relative investigation of coal&blended coalbiomass in various proportion of 95.00:05.00, 90.00:10.00, 85.00:15.00 and 80.00:20.00 as for chosen biomass species.

CHAPTER-2

LITERATURE REVIEW

India’s energy challenges are multi–pronged (Ravindranath et al, 2009). they're manifested through growing demand for contemporary energy carriers, a fossil fuel dominated energy system facing a severe resource crunch, the requirement for creating access to quality energy for the big section of underprivileged population, vulnerable energy security, local and world pollution regimes and the want for sustaining economic development. Renewable energy is taken into account as one of the foremost promising alternatives. Recognizing this potential, India has been executing one of the biggest renewable energy programmes in the world. Among the renewable energy technologies, bioenergy includes a giant diverse portfolio including efficient biomass stoves, biogas, biomass combustion and gasification|chemical change|chemical action} and process heat and liquid fuels. India has also formulated and executed variety of innovative policies and programmes to enhance bioenergy technologies. However, in comparison to some preliminary studies, the success rate is marginal as compared to the potential obtainable. This restricted success could be a clear indicator of the requirement for a significant reassessment of the bioenergy programme. Further, a realization of the necessity for adopting a sustainable energy path to deal with the above challenges are going to be the guiding force during this reassessment. In this paper an effort is made to contemplate the potential of bioenergy to satisfy the rural energy needs: (1) biomass combustion and gasification for electricity; (2) biomethanation for cooking energy (gas) and electricity; and (3) economical wood-burning devices for cooking. The paper focuses on analysing the effectiveness of bioenergy in making this rural energy access and its sustainability in the long-term through assessing: the demand for bioenergy and potential that could be created; technologies, status of commercialization and technology transfer and dissemination in India; economic and environmental performance and impacts; bioenergy policies, regulatory measures and barrier analysis. the complete evaluation aims at presenting bioenergy as an intrinsic part of a sustainable energy strategy for India. The results show that bioenergy technology (BET) alternatives compare positively with the raditional ones. The cost comparisons show that the unit price of BET alternatives are in the range of 15–187% of the traditional alternatives. The global climate change benefits in terms of carbon emission reductions are to the tune of 110 T C every year provided the available potential of BETs are utilized. A majority of the Indian population doesn't have access to convenient energy services (LPG, electricity) (Pillai et al, 2009). Despite the fact India has made significant progress in renewable energy, the share of contemporary renewables in the energy mixture is marginal. This paper analyses the status and potential of various renewables (except biomass) in India. The tendency of the growth of renewables in India and establishes broadcast model as a basis for setting goals. This diffusion model fits to the past trends for small hydro (water), wind and solar water heating and is engaged to discover future targets. The economic achievable and greenhouse emission/gas (GHG) saving potential is calculated for every option. Many renewable resources have high growth rates, for example photo voltaic (PV) module manufacture, wind and solar water heaters. New technologies like Ocean thermal energy conversion (OTEC)), solar thermal power plants, tidal and geothermic power plants are at the demonstration stage and future transmission can rely on the expertise of these projects. Bio-energy technologies (BETs) are conferred as potential carbon reduction opportunities substituting fossil fuel or traditional (less efficient) biomass energy systems (Ravindranath et al, 2006). Cost of energy (saved or produced) of BET's is compared with the cost of energy of fossil fuel and traditional biomass energy systems to estimate the incremental cost (IC). The IC of carbon fading away for every of the chosen BETs (in $GJ-1 or $kWh-1) is estimated using the carbon emission (tC GJ-1 or tCkWh-1) reduction obtained by replacing fossil fuel and traditional biomass alternatives. The fading away costs are estimated and compared for 10 mixtures of BET's (with seven technology alternatives) substituting standard technologies. The above analysis of the chosen biomass shows that out of the selected 10 project cases six have negative IC's that are in the range of (37-688) $ tC-1 and 4 have positive IC's in the range of (52–162) $ tC-1 mitigation. The negative IC's indicate that the recommended alternatives i.e the use of BET's as fuel to many is cheaper than the initial and original technologies. Thus, these results indicate that the chosen BET's are cost-efficient mitigation options and are presently energetic possibilities under Clean Development Mechanism. In view of high energy potentials in non-woody biomass species and an increasing interest in their utilization for power generation (Kumar and Patel, 2008), an effort has been made in this study to assess the proximate analysis and energy content of various components of genus Ocimum canum and Tridax procumbens biomass species (both non-woody) and their impact on power generation and land demand for energy plantations. the net energy content in genus Ocimum canum was found to be slightly more than that in Tridax procumbens. In spite of getting higher ash contents, the barks from each the plant species exhibited higher calorific values. The results have shown that roughly 650 and 1,270 hectares of land area unit needed to come up with

20,000 kWh/day electricity from genus Ocimum canum and Tridax procumbens biomass species. Coal samples, obtained from six completely different local mines, were conjointly examined for their qualities and the results were compared with those of studied biomass materials. This comparison reveals a lot of higher power output with negligible emission of suspended particulate matters (SPM) from biomass materials. The recent statements of each the european Union and the United States Presidency pushed in the direction of using renewable sorts of energy (Angelis-Dimakis et al, 2010), so as to act against climate changes evoked by the growing concentration of carbon dioxide in the atmosphere. In this paper, a survey concerning strategies and tools presently accessible to determine potential and exploitable energy in the most significant renewable sectors (i.e., solar, wind, wave, biomass and geothermic energy) is conferred. Moreover, challenges for every renewable resource are highlighted as well as the available tools that may facilitate in evaluating the use of a mixture of various sources. Renewable energy sources and technologies have potential to give solutions to the long-established energy issues being faced by the developing countries (Kumar et al, 2010). The renewable energy sources like wind energy, solar energy, geothermal energy, ocean energy(OTEC), biomass energy and fuel cell technology can be put to use to overcome energy dearth in India. to fulfill the energy demand for such a quick growing economy, India would require an assured supply of 3–4 times more energy than the entire energy consumed nowadays. The renewable energy is one amongst the choices to satisfy this demand. Today, renewable account for regarding 33% of India's primary energy consumptions.

India is progressively adopting accountable renewable energy techniques and taking positive steps towards carbon emissions, cleanup the air and guaranteeing a more sustainable future. In India, from the last 2 and half decades there has been a lively pursuit of activities about research, development, demonstration, production and application of a range of renewable energy technologies to be used in several sectors. in this paper, efforts have been made to summarize the availability, current standing, major achievements and future potentials of renewable energy choices in India. This paper additionally assesses specific policy interventions for overcoming the barriers and enhancing readying of renewables for the long run.The heating value is one among the foremost important properties of biomass fuels for design calculations or numerical simulations of thermal conversion systems for biomass (Sheng et al, 2005). There are a number of formulae proposed in the literature to estimate the high heating value (HHV) of biomass fuels from the radical analysis data, i.e. proximate analysis, ultimate analysis and chemical analysis composition. In this paper, these co-relations were evaluated statistically based on a bigger database of biomass samples collected from the open literature. it absolutely was found that the correlations based on final analysis are the foremost accurate. The relations based on the performed proximate analysis of the biomass have low correctness because the proximate analysis provides merely an empirical composition of the chosen biomass. The relations build on the bio-chemical blend aren't dependable because of the difference of the ingredients features. The low correctness of previous relations is largely due to the restriction of specimen used for acquiring them. To attain a more robust accuracy, new correlations were projected to estimate the HHV from the proximate and supreme analyses based on the current information. The new correlation between the HHV and dry ash content of biomass (in weight present, wt. %) (i.e. HHV (MJ/kg) = 19.914–0.2324 Ash) can be conveniently accustomed to estimate the HHV from proximate analysis. The new formula, build from the composition of main parts (in wt. %) C, H and O (i.e. HHV (MJ/Kg) = -1:3675 + 0:3137C + 0:7009H + 0:0318O*), is the most correct one, with over 90th predictions inside the vary of ±5% error. The relations based on the proximate information have low accuracy because the proximate analysis provides solely an empirical composition of the biomass. The correlations based on the bio-chemical composition aren't reliable because of the variation of the components properties. The low accuracy of previous correlations is especially due to the limitation of samples used for deriving them. to attain a better accuracy, new correlations were proposed to estimate the HHV from the proximate and ultimate analyses based on the present database. The new correlation between the HHV and dry ash content of biomass (in weight present, wt. %) (i.e. HHV (MJ/kg) = 19.914–0.2324 Ash) could be conveniently used to estimate the HHV from proximate analysis. The new formula, based on the composition of main components (in wt. %) C, H and O (i.e. HHV (MJ/Kg) = -1:3675 + 0:3137C + 0:7009H + 0:0318O*), is the most correct one, with over 90% predictions within the vary of ±5% error. The key technical problems in woody biomass pre-treatment (Zhu and Pan, 2010): barriers to economical cellulose saccharification, pre-treatment energy consumption, especially energy consumed for wood-size reduction and criteria to evaluate the performance of a pre-treatment. A post-chemical pre-treatment size-reduction approach is proposed to considerably cut back mechanical energy consumption. as a result of the ultimate goal of biofuel production is net energy output, an idea of pre-treatment energy efficiency (kg/MJ) based on the overall sugar recovery (kg/kg wood) divided by the energy consumption in pre-treatment (MJ/kg wood) is outlined. it's then used to valuate the performances of three of the foremost promising pre-treatment technologies: steam explosion, organosolv and sulphite pre-treatment to beat lignocelluloses recalcitrancy (SPORL) for softwood pre-treatment. the current study found that SPORL is the best method and produced highest sugar yield. other vital problems, like the effects of lignin on substrate saccharification and therefore the effects of pre-treatment on high-value lignin utilization in woody biomass pre-treatment, are also mentioned. In India, fuel wood, crop residues and animal manure are the dominant biomass fuels (Ravindranath et al, 2005), thatare largely utilized in the rural areas, at terribly low efficiencies. Industrial and municipal (urban) residues like sewer water, municipal solid wastes (MSW) and crop residues like rice husk and bagasse may also be used for energy generation. in this paper, the potential of energy from crop residues, animal manure, MSW, industrial sewer water and biomass fuels that can be conserved for different applications through efficiency improvement is mentioned. the overall potential of energy from these sources in 1997 is estimated to be equivalent to 5.14 EJ, that amounts to slightly more than a-third of the entire fossil fuel use in India. The energy potential in 2010 is estimated to be about8.26 EJ. The potential for the utilization of renewable sources of energy in China and India and their cost effectiveness in air pollution abatement in Asia is studied (Boudri et al, 2002) this can be done through an integrated assessment of the costs and also the environmental impacts of several sorts of renewables, as compared with fossil fuels. Results for various eventualities for fuel use in China and India for the period 1990–2020 are given. The acidification model RAINS-ASIA is employed to analyse environmental impacts (exceedance of crucial loads for acidification) and to perform an optimisation analysis, aiming at minimizing abatement costs. the costs of sulphur dioxide (SO2) emission-control through the switch to renewable energy sources are analysed and compared with the costs of controlling the emissions from fossil fuels (e.g. through flue gas desulfurization). For the environmental targets analysed in this study an elevated use of renewable energies could cut SO2 emission control costs in China by 17–35% and in India by more than two thirds. Postulates that Thailand incorporates a high potential to utilize renewable energy for electricity generation particularly from agricultural waste (Santisirisomboon et al, 2000); but, at present solely a small fraction of biomass is employed for energy purposes. This study aims to calculate the capacity of biomass power generation and its impact on power generation enlargement planning as well as reducing carbon dioxide emission from the power sector. The harvest space and crop yield per area are taken into thought to estimate the long run biomass availableness. The availability of biomass is then applied as a constraint in the least cost electricity generation expansion-planning model. the cost|the price} of CO emissions is additionally added to the fuel prices as carbon taxation to form biomass power generation competitive to fossil fuels and then the optimum value of CO charge is observed. additionally, levels of carbon mono-oxide (CO) limitation from power generation are also introduced to reduce carbon mono oxide (CO) emissions. Renewable energy is basic to cut back poverty and to permit sustainable development (Goldemberg and Teixeira, 2004). However, the idea of renewable energy must be rigorously established, particularly in the case of biomass. This paper analyses the sustainability of biomass, comparing the alleged ‘‘traditional’’ and ‘‘modern’’ biomass and discusses the necessity for statistical data, which can permit the elaboration of situations relevant to renewable energy targets in the world. Biomass-based energy devices developed in recent times (Mukunda et al, 1994). the necessity for this renewable energy to be used in developing countries is initially highlighted. Categorization of biomass in respect of woody and powdery (pulverized) follows, along with equivalence of its energetics with fossil fuels. The technologies concerned, specifically gasifier-combustor, gasifier-engine-alternator combinations, for generation of heat and electricity, are mentioned for each woody biomass and powdery biomass in some detail. The significance of biomass is to obtain finest heat through the use of crushed biomass in cyclone combustors is emphasised. The techno economics is mentioned to point the feasibility of these devices in the present world scenario. the application packages where these devices can fit in and the environment suitable for their seeding are conducted. It is deduced that the main drawback for the utilization of biomass-based technologies stems from the shortage of identification of their true ability. Calorific values of forest waste originating from forestry works like forest cleaning, re-afforestation and, all different silviculture tasks, were measured by static bomb calorimetry (Regueira et al, 2001). These waste materials, as yet considered as useless refuse, are beginning to be used as alternative fuels in wide social sectors everywhere around the globe. two of the most important forest species, eucalyptus and pine existing in {galicia|Galicia|geographical area|geographic area|geographical region|geographic region} are enclosed in this study. another parameters like elementary chemical composition and heavy metal contents, moisture, density and ash percentage after combustion in the bomb, were conjointly determined. The observational outcome, with calorific values exceptional 20,000 kJ /kg make it practical to use these materials as substitute fuel. Proposed a technique to evaluate and exploit the energetic resources contained in several forest formations (Regueira et al, 2004). This methodology is predicated on the use of a combustion bomb calorimeter to determine the calorific values of the various samples studied. These results were complemented with chemical analysis of the samples and with environmental and geomorphological studies of the zones, samples were taken. Predicted ash fusion temperatures by employing the chemical composition of the ash has formely been conducted entirely with linear correlations (Ozbayoglu and Ozbayoglu, 2005). during this study, a replacement technique is bestowed for predicting the fusibility temperatures of ash. Non-linear correlations are developed by employing the chemical composition of ash (eight oxides) and coal parameters (ash content, specific gravity, Hardgrove index and mineral matter content). Regression analyses are conducted using information for Turkish lignites. Regression coefficients and variances of non-linear and linear correlations are compared. the end result shows that the non-linear interactions are superior to linear co-relations for evaluating ash fusion temperatures. Potential implementations of renewable or in-exhaustible energy sources to shift fossil fuel combustion as the major energy sources in various countries and discusses issues corresponding with biomass combustion in boiler power systems (Demirbas, 2005). Here, the expression biomass includes organic matter produced as a results of photosynthesis furthermore as municipal, industrial and animal waste material. Biomass is a pretty renewable fuel in utility boilers. The compositions of biomass among fuel varieties are variable. Ash composition for the biomass and ash composition for the coal is entirely different from each other. particularly inorganic constituents cause to important problems with harmful emissions, fouling and slagging. Metals paticles in ash component, together with totally dissimilar fuel elements like silica ($SiO2$) and sulphur (S) and facilitated by the presence of chlorine (Cl), are to blamed for many undesirable and un-wanted reactions in combustion furnaces and power boilers. Components like Potassium (K), Sodium (Na), Sulphur (S), Chlorine (Cl), Phosphorus (P), Calcium (Ca), Magnesium (Mg), Iron (Fe) and Silicon (Si) are involved in reactions leading to ash fouling and slagging in biomass combustors. Chlorine in the biomass would possibly affect operation by corrosion. Ash sediments diminish heat transfer and will also cause extreme corrosion at high temperatures. Distinctive consequences of biomass formation are revealed for the rates of combustion and pollutant emissions. Biomass combustion systems are non-polluting and supply important protection of the surroundings. The ingestion of greenhouse gases (GHG) contamination is the main fringe of utilizing biomass energy

CHAPTER-3

EXPERIMENTAL WORK

3.1 MATERIALS SELECTION

In this dissertation, 2 various sorts of nonwoody biomass specimen sicklepod or LocalName: Chakundaa) & gulmohar(Localname: Krishanachura) were acquired locally. These biomass species were cut in to totally different pieces and there different part like leaf, emerging branch and main branch were separated from one another. These biomass materials were dried in cross ventilator space for around twenty days. once the wetness contains of those dry biomass sample came in equilibrium therewith of the air, they were crushed in mortar and pestle into powder of -72.00 mess size.

Coal specimen for creating the mix was additionally collected locally. These materials were than processed for the determination of their proximate analysis and Energy values.

Figure.3.1: Specimen of biomasselement, element powder&coal powder

3.2 PROXIMATE-ANALYSIS

Proximate-Analysis incorporates moisture(M), ash, volatile matter(VM), and fixed carbon(FC) contents determination. This was carried out on elements ground to -72.00 mesh size by normal technique. The features of those research are discussed below;

3.2.1 Diagnosis of Moisture

ELECTRONIC BALANCE HOT AIR OVEN HOT AIR OVEN (105 C)

One gram (1.00 gram) of air dried -72.00 mesh size powder of the above said materials was taken in borosil glass disc and heated at a temperature of 105^{0C} ± 5^{0C} for 60 minutes in hot-air kitchen appliance oven. The glass disc was then taken out of the kitchen appliance oven and also the materials were then weighed. The proportion waste in weight was determined that supplies the proportion (%) wetness or within the specimen.

3.2.2 Determination of Ash Content

ELECTRONIC BALANCE MUFFLE FURNACE MUFFLE FURNACE (105 C)

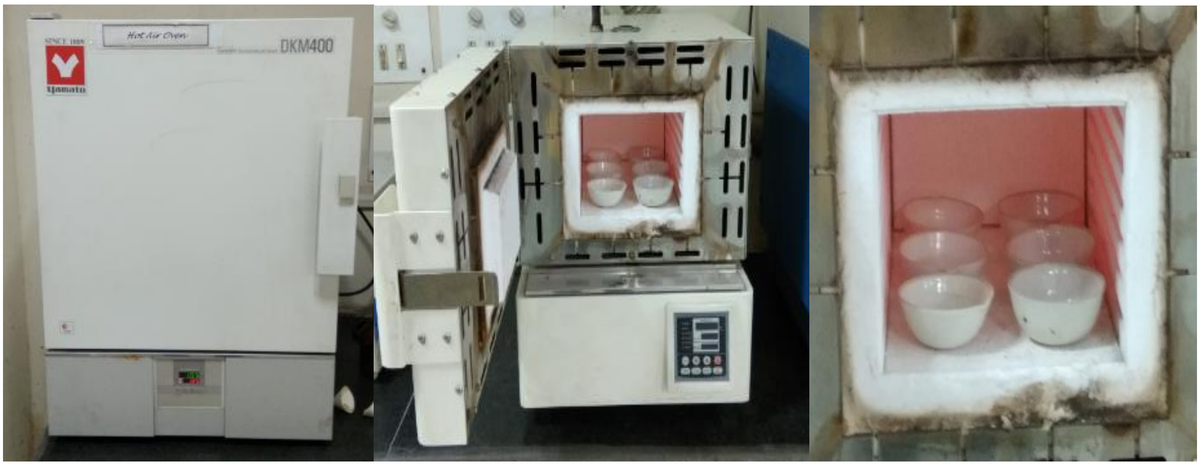
One gram (1.00 gram) of -72.00 mesh size (dried in air) was kept in a very shallow disc made of silica and then placed in a muffle furnace that is maintained at the temperature of 775^{0}C ± 5^{0} C. The materials were kept in rthe furnace & heated for about 60 minutes or till its complete combustion is done. The left out residue was then weighed after taking it out on an electronicbalance. The proportion weightof the left out. Weightof resultant provides theash component within thespecimen.

PercentageAsh = Weight. ofresidue × 100 / Initialweight. of specimen.

3.2.3 Diagnosis of Volatile Matter

1 gram (1.00 gram) of- 72.00 mesh/wreckage measure (dried in open) powderof the chosen materials wastakenin volatilematter vessel (round and hollow in shape and produced using silica). The vessel is roofed on topwithhelp of silicatop. Thevessel wereput ina suppress chamber, kept up at thetemperature of 925.00^0C±5.00^0 C & placed therefor seven minutes. The unstablematter heater werethen takenoutfrom the chamber&cooled inopen atmosphere. The de-volatized tests wereweighted in a gadget adjust&along these lines the extent misfortune inweight ineach ofthe specimen wascomputed. Therate unstablematter insidethe specimenwas controlled by utilizing the resulting equation

Percentage volatilematter(VM) = % loss inthe weigh - percentagemoisture



3.2.4 Diagnosis of FixedCarbon

The fixedcarbon within sample were found implementing the subsequent formulae.

Percentage Fixed Carbon FC = 100.00 ─ (%age Moisture(M) + %age Volatile Matter(VM) + % age Ash)

Where, F.C.: Fixedcarbon, M:Moisture, V.M.:VolatileMatter

3.3 HEATING VALUE DIAGNOSIS

The heatingvalues estimations of thesespecies (-72.00 worksize) weremeasured by utilizing an oxygenbomb calorimeter (BIS, 1970, appeared in Figure.3.3);1 gram of briquette test wastaken ina nicron vessel. A fifteen centimeter stretch of cotton string was set over the specimen inside vessel to encourage in the start. Each the cathodes of the calorimeter were associated by a nicrom meld wire. Oxygen gaswas then charged inside the bomb at a thrust of around twenty five - thirty atmosphere The H_2Owater (2.00 litres) was taken in the basin that was constantly blended to correlate the temperature. The specimen was touched off by exchanging on the ebb and flow throughthe whined wire&turthermore theascent in temperatureof waterwas naturally recorded.The accompanying recipe is utilized to decide the vitality estimation of the example.

Gross heating value (GHV) = {(2500.00 × ΔT)/(Initialweigh. ofspecimen) ─ (heatreleased bycotton thread + Heat exiting byfuse cable)}

Here, ΔT is maximum rising temperature and 2500 is the water equivalent water apparatus.

Figure 3.2: Briquette specimen

Figure 3.3: Oxygen BombCalorimeter (BIS, 1970)

3.4 ASH FUSION TEMPERATURE DIAGNOSIS

The AshFusionTemperature, softeningsTemperature, hemi-spherical temperature&Flow temperatures) of allthe ashspecimen, gotten fromthe picked nonwoody biomass specimen and coalbiomass (in proportion) blended specimen were controlled by utilizing Quartz crucible put in a stifle heater that can warm up to 135.00^0 C in Materials

Sciences Department of the Institution. The presence of specimen tests at I.D.T, S.T, H.T and F.T are appeared in Fig. 3.5.

Figure 3.4: Muffle Furnace

CASSIA TORA



BRANCH **NASCENT BRANCH** **LEAVES**

GULMOHAR



BRANCH **NASCENT BRANCH** **LEAVES**

COAL

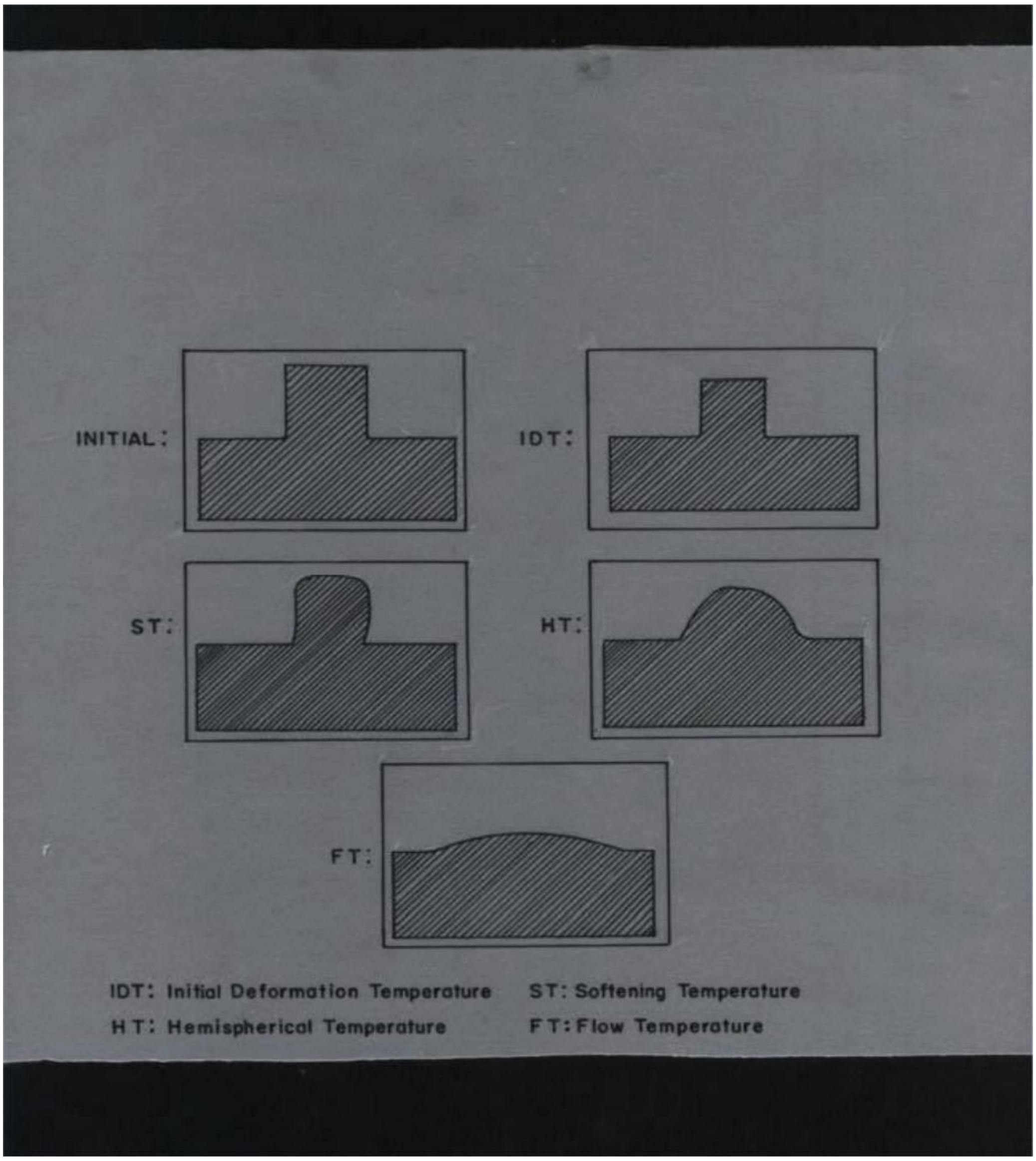


Figure 3.5: Structures of Ash Specimen at 4 Various Characteristic of Ash Fusion Temperatures

CHAPTER-4

RESULTS AND DISCUSSION

4.1 PROXIMATE ANALYSIS OF CHOSEN NONWOODY BIO-MASS PLANT ELEMENTS & COAL-BIOMASS MIXED BRIQUETTE'S

Naturally cut nonwoody biomasses parts contains substantial quantity of free dampness, which ought tobe evacuated to diminish the transportationcost and increment the heating values. In the plant specimen decided for this survey , the time expected to carry their dampness substance into harmony with that of air was observed to be inside the change of fifteen - twenty days amid the mid-year season (temperatures range :35.00-45.00°C and dampness: 6.00-14.00%).

Investigations of the proximate examination of fuels/energy origins are vital on the grounds that they outfit a rough thought with respect to the calorific values and degree of toxins outflows amid ignition. The proximate examination of various elements of Gul-mohar & sickle pod plant and respective biomass specimen part briquette's accompanied with coal are given in Tab4.1-4.5.The data for proximate examination of the elements of these specimen are extremely near each other and thus it's exceptionally hard to reach a solid determination. In any case, it is seen from the tables thatthe sickle pod biomass specimen has fairly greater ash remains and lesser settled carbon substance as compared to those of Gul-mohar bio-mass specimen & the cinder substance being progressively and unpredictable matter is lesser when95.00% coal blendings with5.00% biomass & 90.00% coal blending with10.00% biomass however when85.00% coal blending with15.00% biomass&80.00% coal blending with20.00% bio-mass at that point slag substance is in effect less and unstable matter is more.

4.2 HEATING VALUES OF THE CHOSEN NONWOODY BIO-MASS PLANT ELEMENTS

The heating estimations of the energizes/charge supply are essential standards for choosing its quality to be used in power production in powerplants. It gives a idea with respect to the energy estimation of the fuel and the amount of power production.

Heating value data recorded in Tables 4.1 and4.2 shows that amongst totally examined biomass specimen, heating values of wood elements of each bio masses havehigher when compared with leafs and rising branches. Gul-mohar bio-mass specimen was observed to be bit more than that of sicle pod bio-mass. Tables 4.4 and 4.5 demonstrates that heating estimation of coal blended Gul-mohar bio-mass (distinctive component in a several proportion) were observed to be beyond that of coalblended sicle pod bio-mass (diverse component in a several proportion).

Among the 4 very varying proportions, quantitative connection 80.00:20.00 gives the best heating values in all blended component and 85.00:15.00 likewise gives higher heating component with the exception of leafs segment of every bio-mass in regard to other 2 proportions (95.00:05.00 & 90.00:10.00).

Examination of data recorded in Tab4.1-4.3 demonstrates that in contrast to coals incorporated into the present review, each nonwoody bio-mass material have altogether higher heating values and amazingly bring down powder substance. Tables 4.4 and 4.5 shows that heating values of bio-mass specimens are something lower however powder substance are additionally lower in contrast with coal. This is without a doubt an advantage over non-renewable energy sources. It isin this manner clear that these nonwoody bio-mass assets can prompt higherpower creation in theplant with a small discharge of suspendedparticulate matter (SPM).

4.3 ASH FUSION TEMPERATURE OF CURRENTLY STUDIED NONWOODY BIOMASS SPECIMEN

It moreover through an investigation discovers the ash fusion temperatures to affirm its protected mechanism inside the boiler.Ash remains temperature of strong fuelis a crucial limitation influencing the working temperature of boilers. Clinker formation inside the boiler ordinarily happens subsequently of low ash remains combination temperature&this disturbs the operations of theboiler. Consequently theinvestigation ofthe ash fusion temperature of strong fuel is critical prior its operation inside the boiler. The 4 trademark ash fusion temperatures were known as:(i) Initial-Deformation temperature (I.D.T)–first indication of progress fit as a fiddle;(ii)softening-temperature(S.T)–adjusting of the edges of the 3D square and shrinkages;(iii) hemispherical-temperature(H.T)–distortion of solid shape to hemi-spherical shapes;and(iv)flow-temperature(F.T)–stream of the united mass in an almost level layer. The states of the first taken cubic ash remains tests at I.D.T, S.T, H.T and F.T are appeared in Figure 3.3. Similar structures at these temperatures were acquired for all the examined nonwoody bio-mass specimen like Gul-mohar, sicle pod and coal blended these bio-mass. Information for the ash fusion temperatures (I.D.T, S.T, H.T and F.T) for are recorded in Tables 4.6.

4.4 ENERGY PROCREATION STRUCTURE

The bio-mass based power production system is plotted in Figure1.6 recent trimmed wood have a lot amount of dampness, that has to be expelled to diminish the transportationexpenses &to expand the energy densities (i.e. heating values). The carbonisation of bio-mass provides char-coal as principle item and produces a huge amount (around 65.00%-75.00% of the heaviness of biomass) of volastile matter (pyro-lytic gases). For the bio-mas energy framework to be aggressive and to expand energy transformation intensity, advancements accessible for advancing power production from bio-mass are gasification, ignition, co-burning and bio-metha-ntion. The pyro-lytic gases should be combustd to produce energy. The ash acquired will be sent back to the estate focus & utilized asa compound compost, or can be utilised as construction matter.

4.5 PROXIMATE ANALYSIS AND HEATING VALUES OF VARIOUS ELEMENTS OF NONWOODY BIO-MASS SPECIMEN AND COAL

The outcomes acquired from proximate examination and calorific estimations of nonwoody bio-mass specimen, c0al, c0al-bi0mass consolidated briquettess and Ash fussion temperatures of chose biomass species and coalbio-mass blended (in proportion) sooner or later of the course of this task work had been condensed in Table4.1–4.6 and offered graphically in Figure4.1-4.9.

Tab4.1: ProximateAnalysis of Gul-mohar (Localname: Krishna chura)

Element	Proximate Analysis (Wt. %, air-dried basis)				GrossCalorific Value(K.cal/ k.g, AirDried Basis)
	Moisture	AshContent	Vol. Matt.(VM)	Fixed Carbon.FC	
WoodComp.	8.95	2.90	72.70	15.45	4592
Leaf	8.85	7.30	69.15	14.70	3952
Nascent Branch	9.75	4.25	69.90	16.10	4068

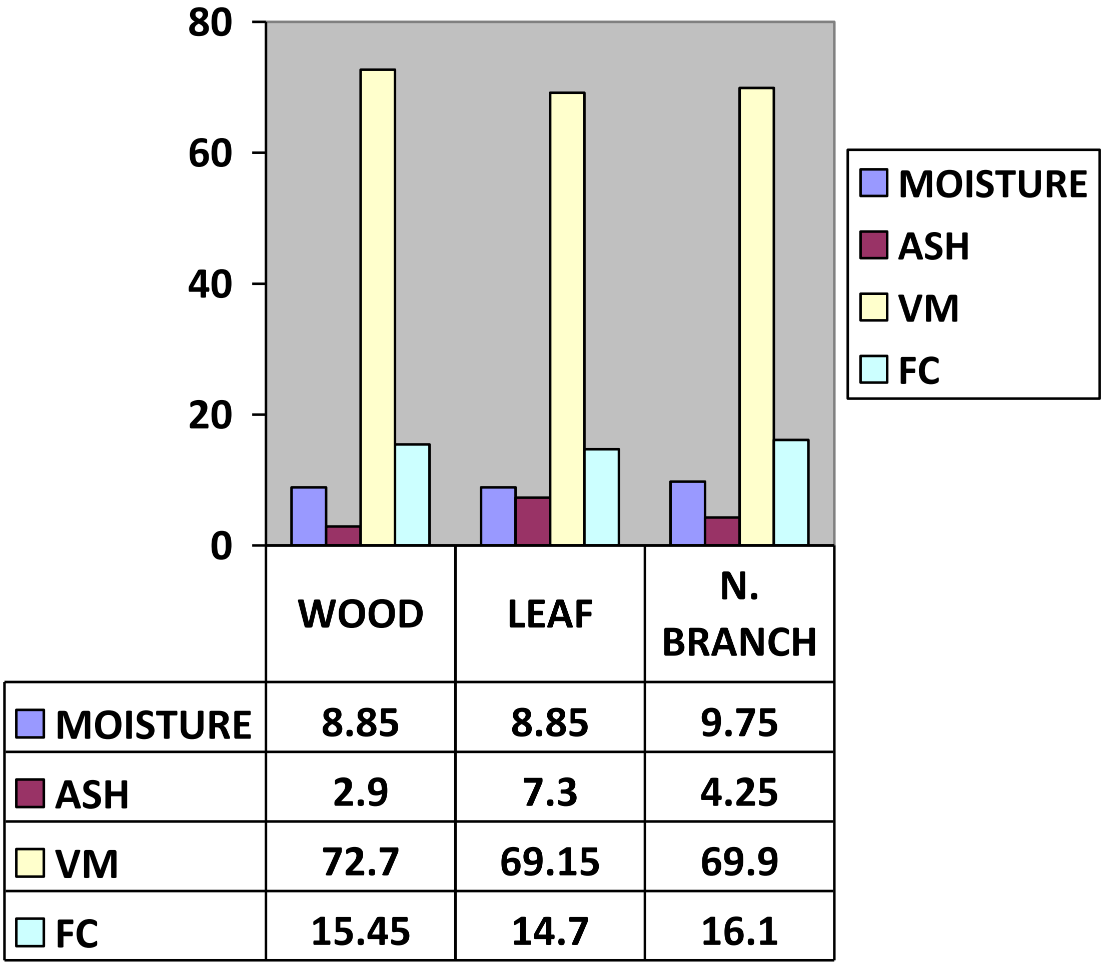


Fig.4.1 Changes in Proximate Analysis of Gulmohar Biomass

Tab. 4.2: ProximateAnalysis of Sicle-Pod (localname:Chaakunda)

Component	ProximateAnalysis (Weight %age, air-dried basis)				HeatingValues (K.cal./ k.g, DriedBasis)
	Moisture	AshContent	Volatile Matter	Fixed Carbon	
Wood Component	12.01	8.10	68.25	11.65	4340
Leaf	12.5	7.80	68.50	11.20	4110
Nascent branch	10.50	5.40	69.50	14.60	3695

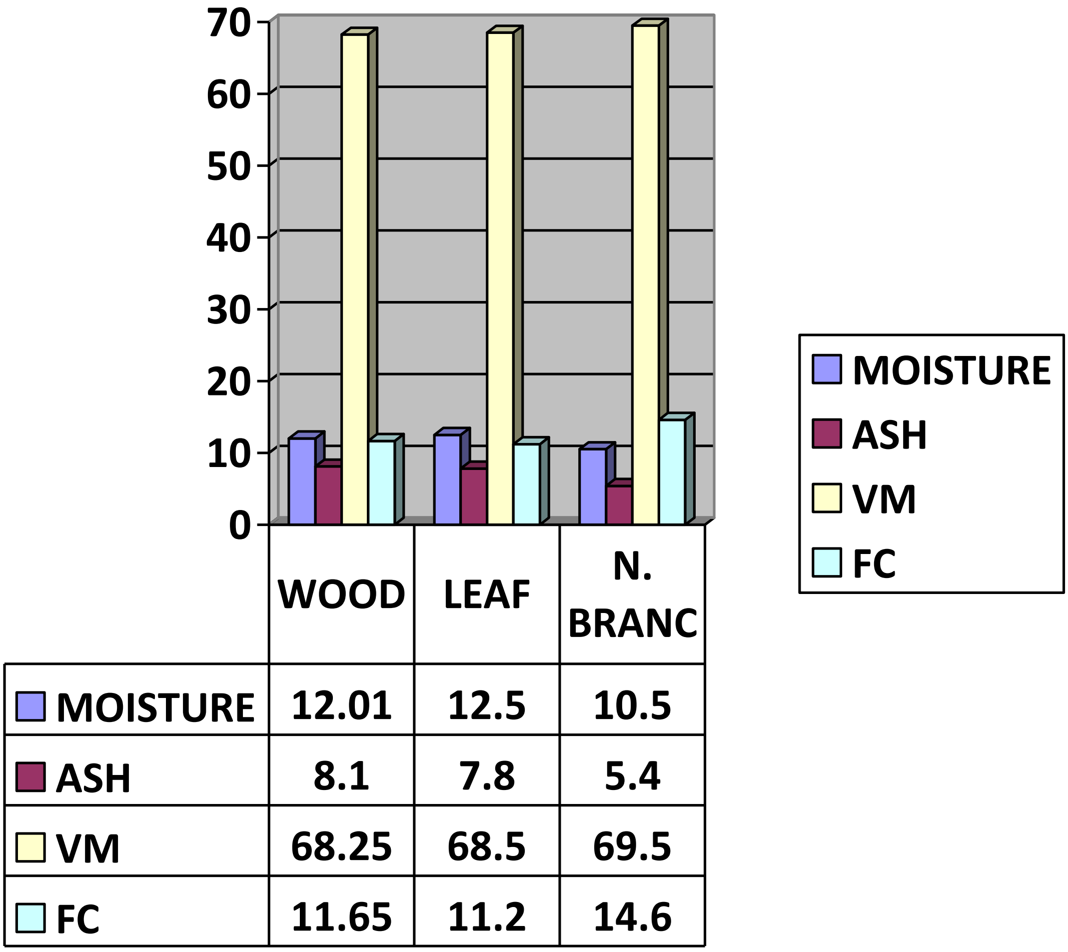


Fig.4.2 Changes in Proximate Analysis of Cassia Tora Biomass

Tab4.3: Prox.Analysis of Noncokingcoal

Element	ProximateAnalysis (Weight %age, air-dried basis)				Heating Values(K.cal./ k.g,\Dried Basis)
	Moist.	AshContent	Vol. Mat. (VM)	Fixed CarbonFC	
Coal	8.8	40.20	20.75	30.05	4343

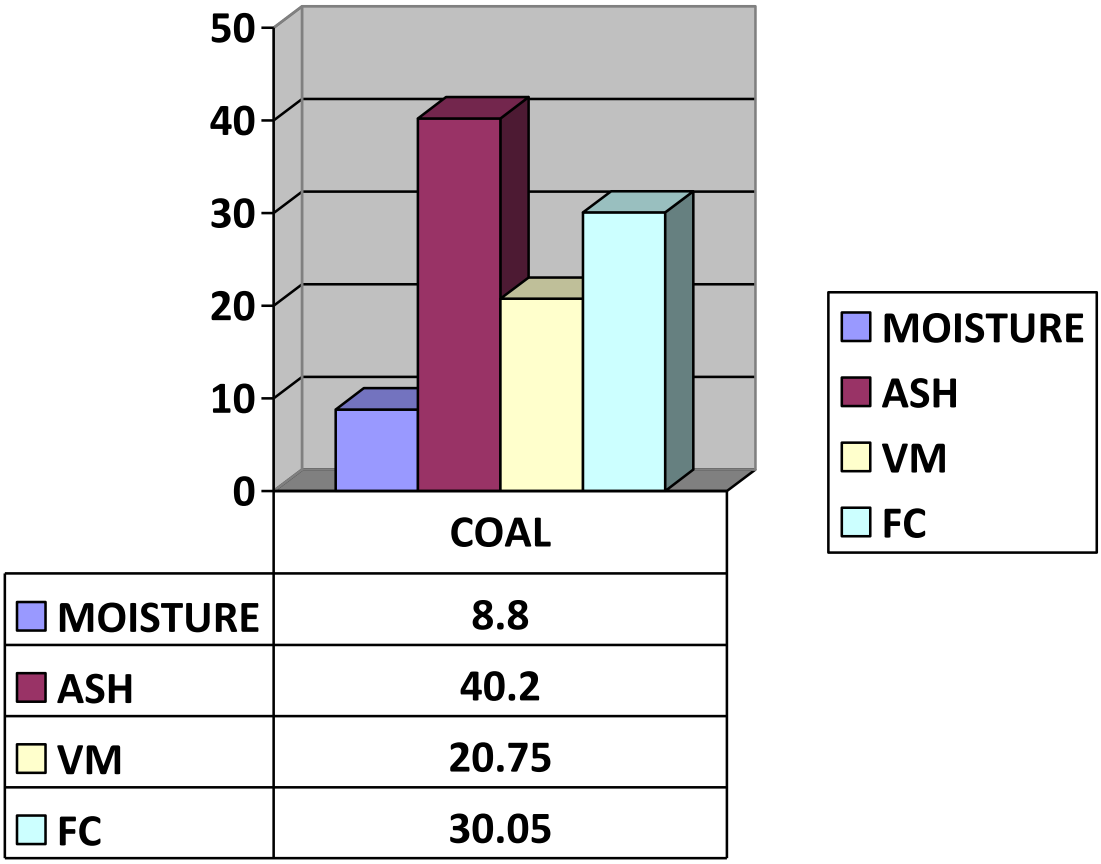
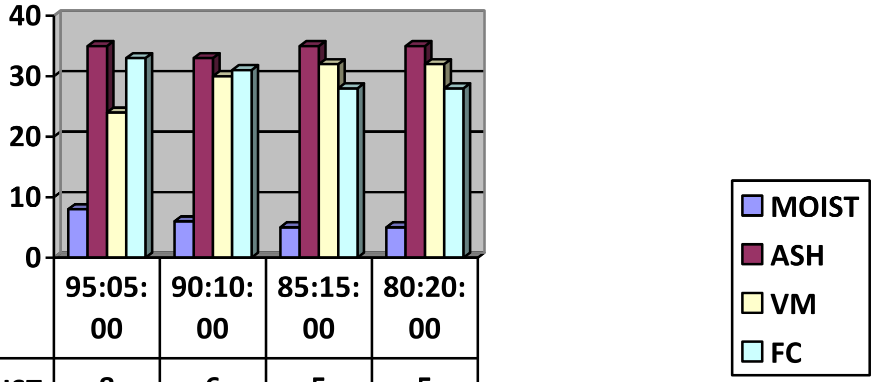


Fig.4.3Changes in Proximate Analysis of Non-coking Coal

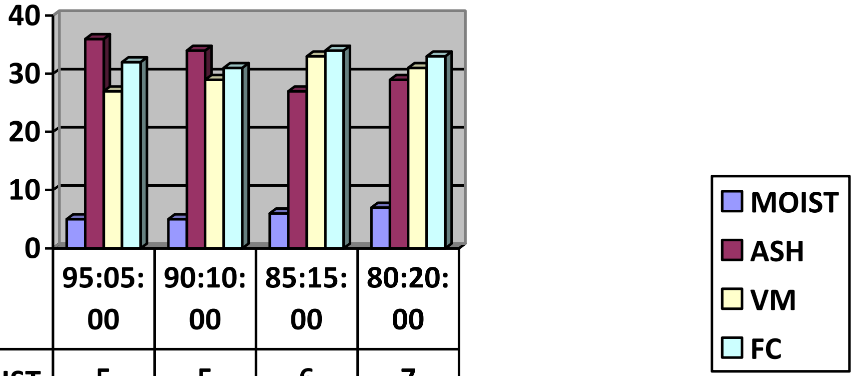
Tab4.4: Coal: Gul-mohar Bio-mass of various Elements

Proportions (Coal: Biomass)	**ProximateAnalysis (Weight%age, air-driedbasis)**				**Heating values (K.cal./ k.g,Dried Basis)**
	Moisture	**AshCont**	**Vol.Matt.**	**Fix.Carbon**	
Main wood					
95:05	8	35	24	33	3212
90:10	6	33	30	31	3495
85:15	5	35	32	28	3745
80:20	5	35	32	28	4085
Leaf					
95:05	5	36	27	32	3420
90:10	5	34	29	31	3480
85:15	6	27	33	34	3075
80:20	7	29	31	33	3837
Nascent Branch					
95:05	5	35	31	29	3582
90:10	4	32	34	30	3550
85:15	7	27	37	29	3555
80:20	8	28	41	23	3798



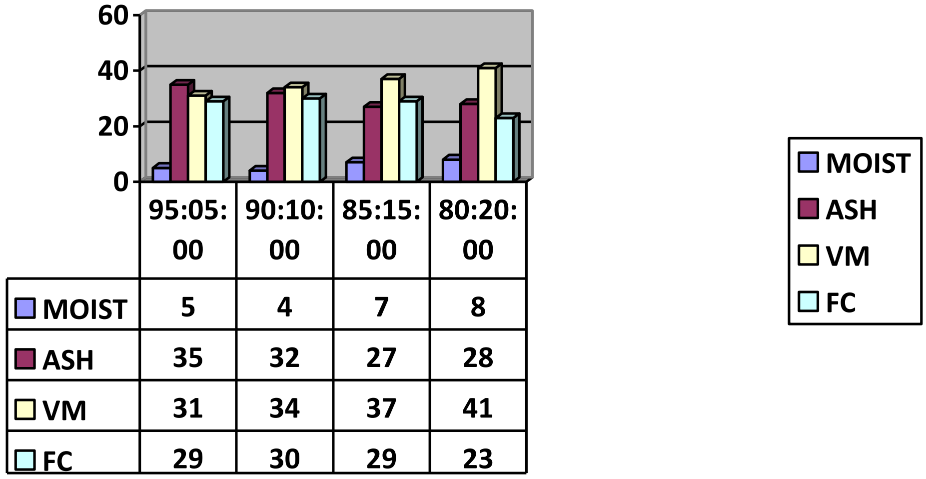
	95:05:00	90:10:00	85:15:00	80:20:00
MOIST	8	6	5	5
ASH	35	33	35	35
VM	24	30	32	32
FC	33	31	28	28

Fig4.4Changes in blend of Coal & Gul-mohar Bio-mass(Wood.)



	95:05:00	90:10:00	85:15:00	80:20:00
MOIST	5	5	6	7
ASH	36	34	27	29
VM	27	29	33	31
FC	32	31	34	33

Fig4.5 Changes in blend of Coal & Gul-mohar Bio-mass(Leaves.)

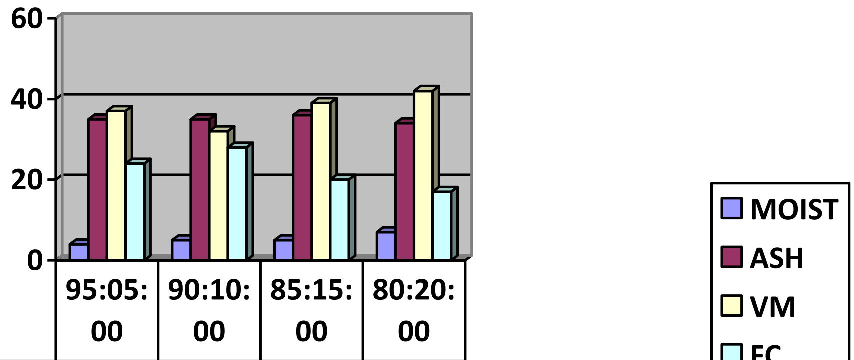


	95:05:00	90:10:00	85:15:00	80:20:00
MOIST	5	4	7	8
ASH	35	32	27	28
VM	31	34	37	41
FC	29	30	29	23

Fig4.6 Changes in blend of Coal & Gul-mohar Bio-mass(Fresh Branches.)

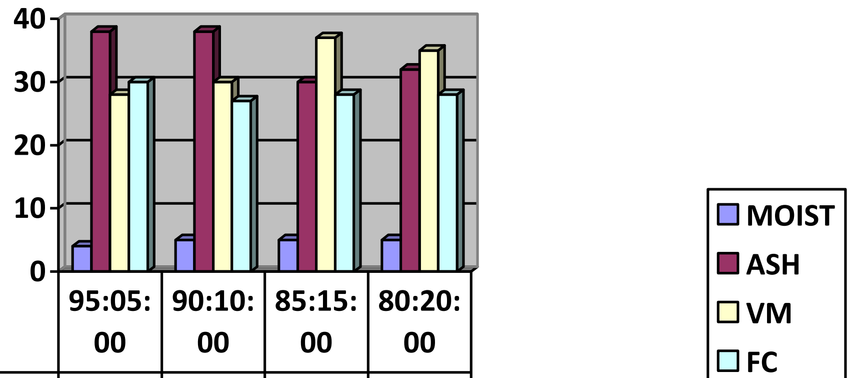
Tab4.5: Coal:SiclePod Bio-mass various elements

Proportions (Coal: Bio-mass)	**Proximate Analysis (Wt. %, Air Dried Basis)**				**Heating value (K.cal./k.g,Dried Basis)**
	Moisture	**AshCont**	**Vol. Matt.**	**Fix, Carbon**	
Main wood					
95:05	4	35	37	24	3140
90:10	5	35	32	28	2975
85:15	5	36	39	20	3479
80:20	7	34	42	17	3457
Leaf					
95:05	4	38	28	30	3273
90:10	5	38	30	27	3672
85:15	5	30	37	28	3050
80:20	5	32	35	28	4144
Nascent Branch					
95:05	5	38	33	24	3473
90:10	8	35	27	30	3213
85:15	4	29	39	28	3677
80:20	4	37	39	20	3670



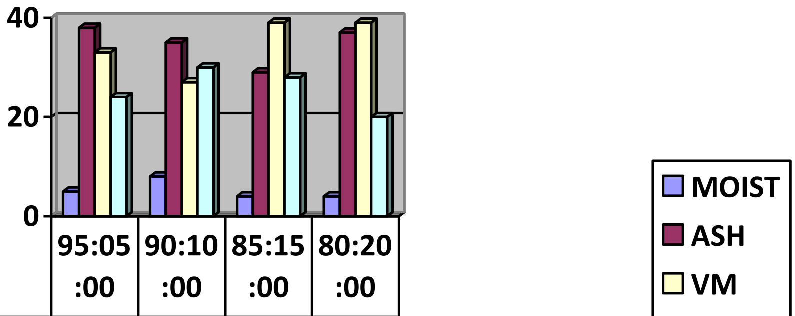
	95:05:00	90:10:00	85:15:00	80:20:00
MOIST	4	5	5	7
ASH	35	35	36	34
VM	37	32	39	42
FC	24	28	20	17

Fig4.7 Changes in Blend of Coal and SiclePod(Wood)



	95:05:00	90:10:00	85:15:00	80:20:00
MOIST	4	5	5	5
ASH	38	38	30	32
VM	28	30	37	35
FC	30	27	28	28

Fig4.8Changes in Blend of Coal and SiclePod(Leaves)



	95:05:00	90:10:00	85:15:00	80:20:00
MOIST	5	8	4	4
ASH	38	35	29	37
VM	33	27	39	39
FC	24	30	28	20

Fig4.9Changes in Blend of Coal and SiclePod(Fresh Branch)

Table4.6:Ash Fusion Temperatures of Chosen Bio-mass Specimen and Coal-Biomass Blended Specimen

Biomass Specimen / Coal-Biomass Mixed Ratio	**AshFusionTemperatures(°C)**			
	I.D.T	**S.T**	**H.T**	**F.T**
Sicle-Pod	885	1240	>1300	>1300
Gulmohar	1055	1245	>1300	>1300
Coal : Biomass (90:10)	1155	1295	>1300	>1300
Coal : Biomass (80:20)	1185	1295	>1300	>1300

I.D.T:Initial Deformation Temperature

S.T:Softening Temperature

H.T:Hemispherical Temperature

F.T:Flow Temperature

4.6 CALCULATIONS

Tab4.7: Complete Energy Values & Power Production Structure from 8 Month aged (approx.), Gul-mohar Plants

Elements	**HeatingValue (kcal/t, dry basis)**	**Biomass Prod. (t/ha,dry-basis)**	**Energy Value (k.cal./ha.)**
Main wood	4532×10^3	21.00	95172×10^3
Leaves	3907×10.0^3	7.00	27349×10^3
Nascent-branch	3997×10.0^3	9.50	37971.5×10^3

* Data from old research (biomass generation)

Energy Calculation:

On equally dried=basis, complete energy that can be obtained by 1 hectare of land:

$$= (95172.00+27349.00+37971.50) \times 10^3$$

$$= 160492.50 \times 10^3 \text{k cal}$$

It is anticipated that changing proficiency of wood fuelled warm plants=26.00 % & mechanical productivity of the powerplant = 85.00 %.

Energy estimation of the aggregate useful biomass gotten from 1 hect. of land at 26.00% transformation productivity of thermal powerplant :

$$= 160492.50 \times 103.00 \times 0.26$$

$$= 41728.05 \times 10^3$$

$= 41728.05 \times 10^3 \times 4.186.00 \div (3600.00)$

$= 48520.4493$ k Wh

Power generation at mechanical efficiency= 85.00 %:

$= 48520.45 \times 0.85$

$= 41242.3819$ k Wh/ha

Land required to produce energy for a whole year:

$= 73 \times 10^5 / 41242.38$

$= 177.002$ hec.

Tab4.8: Complete Energy Values & Power Production Structure from 4 Month aged (approx.), Sicle-pod Plants

Elements	**Heating-Value (k.cal/t,drybasis)**	**Biomass Production (t/ha, dry basis)**	**Energy-Value (k.cal./ha)**
Main wood	4344.0×10^3	4.00	17376×10^3
Leaf	4013×10^3	1.50	6019.5×10^3
Nascent branch	3672×10^3	2.500	9180.0×10^3

* Data from old research (biomass generation)

Energy Estimation:

On equally dried=basis, complete energy that can be obtained by 1 hectare of land:

$= (17376.00+6019.50+9180.00)\times10^3$

$= 32575.50\times10^3$kcal

Transformation efficiency of wood-fuelled thermal engines is presumed that at=26.00% & powerplant's mechanical efficiency be =85.00 %.

Heating values of the complete practical biomass acquired from 1 hect. of land at 26.00% conversion efficiency of thermal powerplant $= 32575.50\times10^3 \times 0.26$

$= 8469.63\times10^3$k.cal

$= 8467.29\times10^3 \times4.186\div 3600$

= 9848.2975k.Wh

Power production at mechanical efficiency=85.00 %

$= 9848.2975\times0.85$

= 8371.0528 k.Wh/ha

Hectares of land needed to provide energy in for of electricity for a complete year:

$=73\times10^5/ 8371.05$

=872.0527h

CHAPTER-5

CONCLUSIONS

5.1 CONCLUSIONS

In the current diagnosis 2 nonwoody biomas specimen Gulmohar and sickle pod were picked. Investigations to see the proximate examination, heating values and ash fusion temperature was concluded on every of the elements of the picked specimen like primarywood; leaves&developing branch were done. Evaluation was done to dissect the quantity of power that might be created in 1 hect. ofland from every specimen. Underneath are the various findings concluded from the current deed:

1. Each plant specimen (Gul-mohar&SiclePod) indicated nearly the comparative proximate examination comes about for their elements, the ash remains are greater in their leaves and volatile matter substance lesser in Siclepod wood&leaves.

2. Different proportion of each biomass mixedwith proportions of coal (in 4 entirely dissimilar proportion) additionally demonstrated identical proximate examination comes out, the ash remains being extra in 95.00% coal blended with 5.00% biomas and volatile component matteris additional when80.00%coal blended with 20.00% bi-omass.

3. The nonwood bio-mass specimen demonstrated most astounding heating values for branches, trailed by wooden component, leaves and rising branch.

4. Among the chosen bio-mass specimen Gul-mohar has the most astounding heating value when contrasted with cassiatora.

5. Amongs the 4 entirely differing proportion, proportion 80.00:20.00 gives the most astounding heating values contrasted with 95.00:05.00, 90.00:10.00, 85.00:15.00.

6. Heating values of coal blended with Gul-mohar biomass elements were observed tobe a littlehigher compared to thatof coal blended cassiatora bio-mass component.

7. Assessment outcomes have built up that about 177.002 and 872.0527 hectares of ground would be required for nonstop production of 41242.3810k.W.h/hectares from Gul-mohar and 8371.0528k.Wh/hectares from cassiatora biomass specimen.

8. The ash fusion temperature of the considerable number of specimen are resulting higher than the scope of boiler functioning, this could evade from clinker development inside the apparatus.

9. This review might be sure in the utilization of nonwoody biomass specimen for energy production.

5.2 SCOPE FOR FUTURE WORK

The current review is centered around 2 nonwoody bioma-ss specimen like Gul-mohar and Cassiatora. The consequent effort are prescribed to be completed in future.

- Such sort of effort should be reached out for an additional nonwoody biomas specimen accessible in the native space.

- The bimass specimen could likewise be blended with dairy animals dung, sewage squanders, and so forth in various proportions and in this manner the power creation possibilities of the blends could likewise be resolved.

- Pilot plant survey on research scale could likewise be done to get power from biomass specimen.

- The fine specimens of those biomas speciemen could likewise be blended with animal waste and in this manner the power created capability of the resulting blended briquettes could likewise be examined.

- New methods of power production from biomassspecimen could likewise be created

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