Potentiality of Biomass Energy for Electricity Generation in Bangladesh

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ABSTRACT

Biomass gasification is quite new in Bangladesh and may be considered as a promising technology for power generation. Electricity generation by biomass gasification can solve the problems of our day-to-day life at a great extent. Even it also serves the purpose of rural electrification which is the crying need of Bangladesh. Besides producing electricity it is beneficial to the agricultural and industrial production. Some small enterprises trying to ensure energy security at countryside using biomass gasification by rice husk. This paper includes availability, proper selection and quality of biomass throughout the country and utilization of by-product released by the plant. A case study is incorporated which applies biomass gasification technology in Bangladesh, to generate power from rice husk. In addition it includes how ash generated from the husk is processed to produce silica and calcium carbonate through silica precipitation method in order to minimize the production cost.

Key-words: Biomasss, Gasification, Power generation

1 INTRODUCTION

Energy is the basic necessity for the development of a country and electrical energy is superior to all other forms of energy. The modern society is so much dependent upon the use of electrical energy that it has become a part and parcel of our life. Infect the advancement of a country is measured in terms of per capita consumption of electrical energy. Bangladesh is one of the most densely populated countries with about 80% of the population living in rural areas. However, only about 38% of its total population has

access to the electricity. Without the development of rural electrification it is impossible to fulfill Bangladesh Governments vision of ensuring access to affordable and reliable electricity for all by 2020. The main energy sources of Bangladesh are biomass and natural gas. Where biomass energy is about 70% of the total energy consumption in Bangladesh[1].In rural areas normally direct combustion is the most common method of biomass utilization. Because of its poor efficiency and limited supply alternative techniques of resource utilization can meet the energy demand in this case.

South and Southeast Asia account for over 90% of the world's rice production [2].Rice husk is a major by-product of the rice-milling industries and is abundantly available. However, rice husks have been considered a waste, causing disposal problems. Like most other biomass materials, rice husk contains a high amount of organic volatiles. Thus, rice husk is recognized as a potential source of energy. Moreover, its 20 wt. % (approximately) ash content comprising of over 95% amorphous silica makes a rice husk utilization system economically and environmentally attractive.
Gasification of biomass has been known as one of the effective technology options for the utilization of this renewable energy resource. Many interesting investigations concern the subject of biomass gasification from the points of view of fuel used, gasifier type, kinetic and product specifications and uses. Other neighboring Asian countries especially India and China have already undertaken gasification programs on large scale. On the other hand, only a demonstration biomass gasification of 200 kW based on rice husk is being set up by Local Government Engineering Department (LGED) at Dinajpur. The first commercial rice husk based power plant is established by a private entrepreneur in Kapasia, near Dhaka with financial assistance from Infrastructure Development Company Limited (IDCOL).

2 Biomass Gasification Basics

Biomass gasification is the process of converting solid fuels (wood/ wood-waste, agricultural residues etc.) into a combustible gas mixture. This is achieved by reacting the material at high temperatures (>700 °C), without combustion, with a controlled amount of oxygen and/or steam. The resulting gas mixture is called syngas or producer gas and is itself a fuel. The power derived from gasification of biomass and combustion of the resultant gas is considered to be a source of renewable energy. The calorific value of this gas varies between 4.0 and 6.0 MJ/Nm3 or about 10 to 15percent of the heating value of natural gas [3]

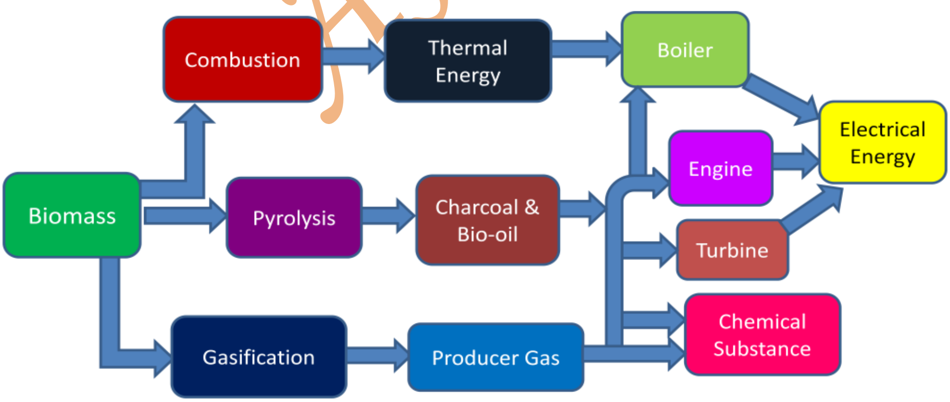

Figure1, Biomass conversion into energy [4]

The three different stages of total gasification procedure are:

- Gasification process starts as auto thermal heating of the reaction mixture.
- In the second stage, combustion gases are pyrolysis by being passed through a bed of fuel at high temperature.

- Initial products of combustion, carbon dioxide (CO_2) and (H_20) are reconverted by reduction reaction to carbon monoxide (CO), hydrogen (H_2) and methane (CH_4).

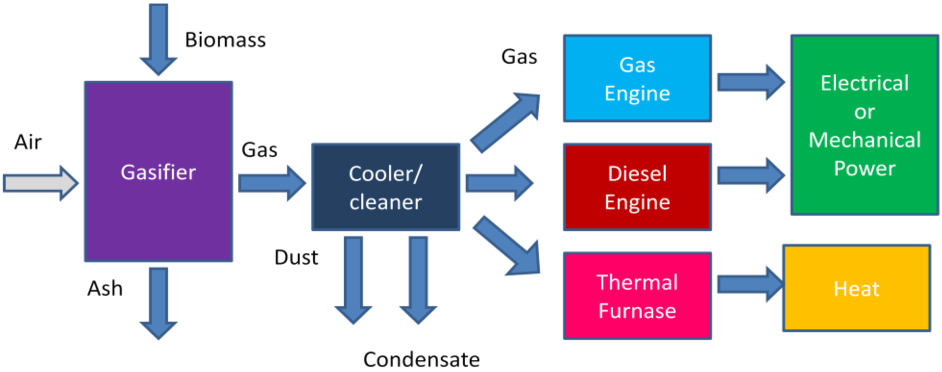

Figure 2, A flow diagram of BGT

3 Availability and use of Biomass in Bangladesh

Bangladesh is an agriculture-based country and the available biomass is mainly of agricultural residues like rice husk & rice straw from rice plants, Biogases from sugarcane, Jute stick, residues from Wheat, potato, oilseeds, spices etc. In addition to the agricultural wastes the other sources are dry materials such as dry wood, dried leaf, charcoal, coconut shells etc.

Over last 30 years, there has been an increasing trend of biomass fuel supply in Bangladesh. The total supply of biomass fuel was 236.08 PJ in 1980 and has increased over next 20 years to 356.66 PJ (1.73% growth). Traditional fuel supply usually comes from main three sources viz. crop residues, animal dung and trees [5].

The percentages of different traditional energy were as follows: cow-dung 20.4%, jute stick 7.5%, rice straw 11.6%,rice husk 23.3%, bagasse 3.2%, fire wood 10.4%, twigs and leaves 12.5% and other wastes 11.1%. Rice husk contributes biggest share of biomass energy and it was 83.04 PJ in 2003-2004. Energy production from rice husk is steadily increasing.

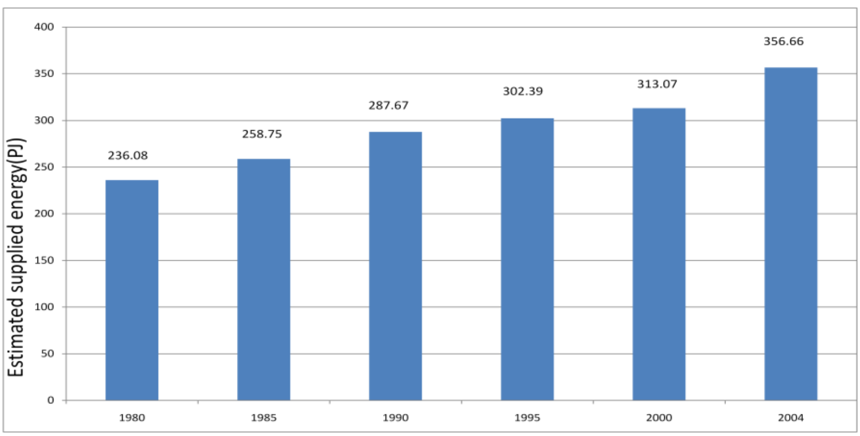

Figure 3, Trends of traditional fuel supplied during 1980 to 2004

In 1991, the production of rice husk energy was 76.35 PJ and it increased to 106.1 PJ in 2004 (Figure 3.2) [5].

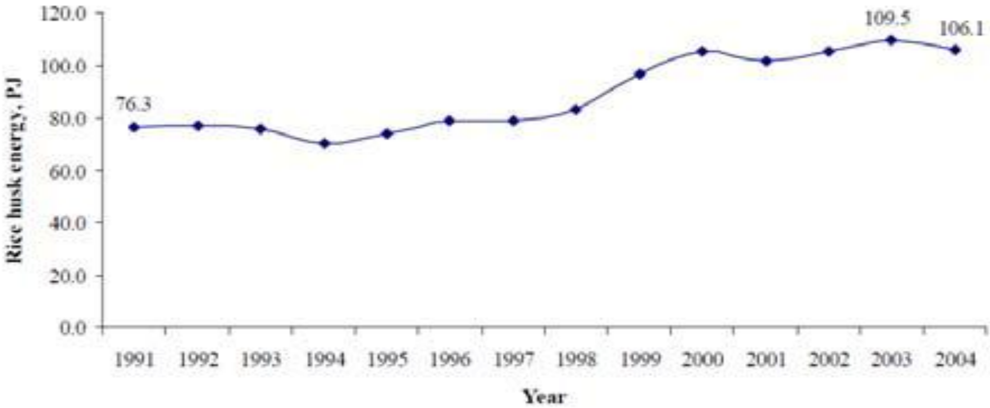

Figure 4, Trends of traditional fuel supplied during 1980 to 2004[5]

4 Biomass Characteristics

Gasification technology requires some important bio mass characteristics the moisture content of biomass should be as low as possible. No of volatile matter content, ash content and composition must be considerably low. Morphology and bulk density should be constant.

Figure 5, Rice husks & wood chips

5 Electricity Generation by Rice husk Gasification

Several types of gasifier e.g. fixed-bed updraft and downdraft gasifier, fluidized bed gasifier and bubbling bed gasifier are available in the existing market with different sets of pros and cons. However, the downdraft gasifier is a comparatively cheap and the gasification in this type of gasifier can produce a product gas with very low tar content [4]. Keeping the process in mind, fixed-bed downdraft gasifier is thus recommended for small-scale rice husk biomass plant. Here, biomass fuel is fed at the top of the reactor/gasifier. The fuel then slowly moves down and during this time, the fuel reacts with air (the gasification agent), which is supplied by the suction of a blower or an engine and is converted into combustible producer gas in a complex series of oxidation, reduction, and pyrolysis reactions [3]. Generated ash is then removed from the bottom of the reactor for silica production.

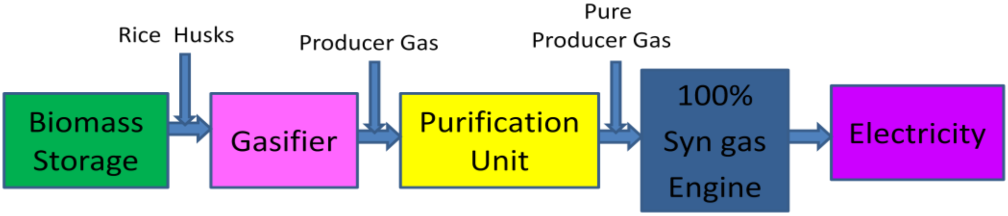

Figure 6, Electricity generation by rice husk gasification.

6 PROGRESS OF TECHNOLOGY INCLUDING CASE STUDY

Over the years a considerable number of gasification systems for demonstration purposes have been financed worldwide. A large diversity of fuels and equipment was experimented with.

A decade of experience with modern biomass technologies for thermal, motive power and electricity generation applications exists in India. Gasifier technology has penetrated the applications such as village electrification, captive power generation and process heat generation in industries producing biomass waste. Over 1600 gasifier systems, having 16 MW total capacity, have generated 42 million Kilo Watt hour (KWh) of electricity, replacing 8.8 million liters of oil annually (CMIE, 1996). An important aspect of small gasifier technology in India is the development of local manufacturing base. Technology improvement is also derived from joint ventures of Indian firms with leading international manufacturers of turbines and electronic governors [6]. Like India in China 150 set of gasifier used for generating electricity,160 set for cooking & 370 set for drying woods.

The only gasification plant in our country namely "Dreams Power Limited" located in Gaspur in Kapasia, Gazipur. IDCOL provided concessionary loans and grants to Dreams Power Private Limited (DPPL), the Project Sponsor, for setting up the plant. Ankur Scientific Energy Technologies Pvt. Ltd, India is the equipment supplier of the project, although some of its parts come from German and Italy.

The main parts of the plants are:

1. Two Downdraft gasifier,
2. A dual-fuel generator,
3. Four Electric motor &
4. A spray pond

A mini grid has been constructed to sell the power to the adjacent area. The plant is able to deliver power to at least 200 households and over 100 commercial entities of that area.

At present only one unit is on running condition from two, and this unit produces 56-KW only. The plant is no longer capable of supplying more than 50 houses.

Figure 7, Rice Husk fired 250 kW Gasifier power plant and Spray pond at Kapasia, Bangladesh.

Dreams Power Limited now supplies about 333 unit/day (56-KW * 6-hr = 336 KW-hr or unit). It runs 6hrs a day. The sales cost of each unit is 5 TK. Therefore the monthly income of the plant equals to 333 * 5 * 30 = 49950 i.e. about 50000 TK. But it cost pretty more than income.

The loss of the existing plant can be minimized in two ways:

- By establishing plant at rice mill cluster areas &
- By utilizing the ash generated from rice husk.

According to the Rice Mill Owners' Association of Bangladesh there are over one hundred thousand rice mills located in a scattered manner all over the country with four 'cluster' areas. These four distinct 'cluster' areas are distinguished as - (i) Dinajpur (North Bengal) (ii) Sherpur (near Bogra) (iii) Inshawerdi and (iv) Kaliakoir (near Dhaka),where most of the rice mills are located in close proximity to each other.

Figure-6.2: Districts with rice mill clusters (star marked) in Bangladesh [7]

Based on preliminary surveys (Ref.: Bangladesh Rice Research Institute, BRRI and information from Rice Mill Owners' Association), typically at least over 500 rice mills are located in these cluster areas. Taking an average (lower-mid) capacity range of about 100-200 kW, there is a 50-100 MW power market in these cluster areas [8].

Silica generation is a separate independent process not dependent on electricity generation, although the input ash is dependent on gasification process. Provision will be taken in the design so that external ash is used also as input thus increase silica production. The process along with three major steps of production is depicted in below mentioned figure.

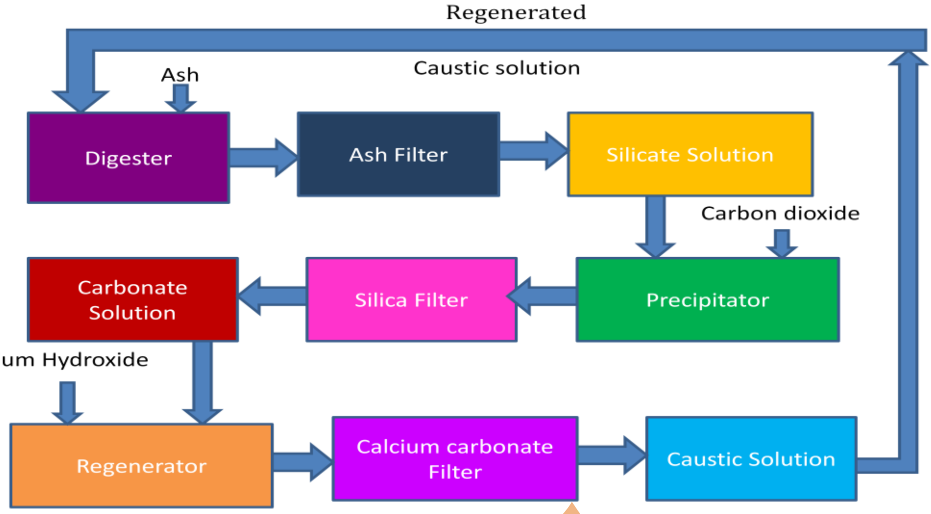

Figure-6.3: Flow chart of precipitated Silica [9]

(a) Digestion

This step involves the digestion of the rice husk ash with caustic to formulate sodium silicate solution at specific condition. After the digestion stage, the solution is filtered for residual undigested ash present in the solution. The clear filtrate is then taken for precipitation.

Ash + NaOH (l) Na2O.xSiO2 (l) + Undigested ash (1)

(b) Precipitation

This step involves precipitation of silica from sodium silicate solution in presence of CO_2. The precipitated silica is then filtered, washed with water to remove the soluble salts and dried to form silica powder. The filtrate containing sodium carbonate is taken for regeneration purpose [10].

Na2O.xSiO2 (l) + CO2 (g) xSiO2 (s) + Na2CO3 (2)

(c) Regeneration

Regeneration is the step where calcium compound reacts with the sodium carbonate to form calcium carbonate and sodium hydroxide. The resulting solution is filtered to remove the solid calcium carbonate and the aqueous sodium hydroxide is used for digestion again [9].

Na2CO3 (l) + Ca(OH)2 (s) CaCO3 (s) (3)

CaCO3 (l) Ca(OH)2 (s) + CO2 (4)

7 Conclusion & Future work

The long-term potential contributions of modern biomass energy carriers in Bangladesh are significant. The Biomass power plant in Kapasia is a milestone in country's history to promote and develop renewable energy. New policies and programs are needed to address institutional barriers to expanding the use of modernized bioenergy in Bangladesh, and to ensure that biomass is used for energy in environmentally-sensitive ways.

In order to flourish this technology in near future following factors should be considered:

- Recognition,
- Attitudinal Barriers to shift,

- Available Loan facility,
- Cost of installation,
- Type of fuel to be used and its availability,
- Efficiency,
- By-product utilization.

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