

Feasibility Study on Power Generation in Bangladesh using Rice Husk as an Alternative Source of Fuel

Md. Amanullah Kabir¹, Md.Saiful Alam Shabbir^{2*}, A.H.M Fazle Elahi³

^{1, 2, 3} Department of Mechanical Engineering
Khulna University of Engineering & Technology, Khulna-9203, Bangladesh

ABSTRACT

Bangladesh is currently facing power crisis which has become worse in recent years. The cost of power generation that is increased drastically with an unprecedented surge in international fuel price. The rising cost of fuel is the main reason to seek the alternative source of fuel. Rice husk, which is a by-product of Rice processing is identified as an important and potential alternative fuel source for generating power. Bangladesh is an agricultural country which is dominated by Paddy cultivation. Bangladesh has reportedly over fifty thousand Rice mills—small, medium, large. They process Paddy collected from rural areas. The Rice mills use the thermal energy of steam which is generated in boilers by firing the Rice husk. It is globally well-known and convenient source of dry biomass energy of reasonable heat value. In Bangladesh context out of 38 million tons of total biomass produce from agro-residues, rice husk contributes about 28% by mass. Rice husk is considered to be an environment friendly fuel because it can minimize CO₂, SO₂ and NO_x emissions when compared with conventional fuel. In this research four major rice processing districts were selected to estimate potential husk available for electricity generation. The selected Rice mill Clusters are located at Bogra, Dinajpur, Rajshahi and Rangpur. More than hundred numbers of rice mills were surveyed in this research to know about annual Paddy processing capacity and surplus amount of husk from the four selected rice processing zones. Based on the collected data, potential power capacities were estimated in four selected districts considering the steam turbine technology. A systematic approach can give birth to a new industrial sector of Rice husk based power generation in Bangladesh.

Keywords: Rice mill, Rice husk, Alternative energy source, Power generation, Environmental impact.

1. Introduction

Bangladesh is an Agricultural country. In Bangladesh Rice is a staple food and accounts for about 93% of the total food produced in country. Bangladesh produces on average 33890 thousand MT (2011-2012) Paddy per year, giving approximately 6778 thousand MT Rice husk [1]. Generally Rice husk constitutes about one fifth or 23% (by weight) of the dried paddy Rice. Bangladesh has 53423 Rice Mills (Large, Medium, and Small). Approximately 95% Rice husk is produced by milling process of Rice Mills. Rice husk can be converted into different types of fuel through a variety thermo-chemical conversion process. So Rice husk can be used as a potential source of heat energy and one of the largest source of biomass because it contributes 26% of the total about 42390 thousand MT biomass produced in Bangladesh. At present in Bangladesh about 70-75% of Husk is consumed for steam production in mills. The average Calorific value of Rice husk in natural and dry state is 14700kJ/kg. The Moisture Content present in Rice husk, is ranged between 8.68-10.44%, ash content is ranged between 23.39-24.10% and the bulk density is ranged between 86-114 kg/m³. The Paddy of 1 ton consumes approximately 30-60 KWh to give 600-700 kg of Rice and the Rice husk as a residue of 220 kg which is equivalent to power generation of 90-125 KWh. Bangladesh has a big crisis in energy sector in power generation because of simultaneous increase in cost of fuel and its consumption. At present installed capacity in power generation is 8716 MW, installed capacity is

8100 MW, demand forecast is 7518 MW, maximum peak generation is 6060 MW and maximum load shedding is 1058 MW. According to report of BPD (2010-2011), power consumption pattern of the country - Domestic (44.49%), Agriculture (2.69%), Industrial (39.34%), Commercial (10.99%), others (2.49%) of total 6380 MKWh (cumulative) and sector wise number of consumer in rural electricity is 9085810 MKWh (Cumulative) and for power generation Import of coal and coke from other countries is 7.39 MT and fuel consumption by power plant is 151048 million Cft (natural gas), 182 million Litre (Furnace oil), 60 million Litre (HSD, SKD, SKO & LDO) [1]. So for the purpose of recover fuel consumption as well as fuel cost as possible by few percentage Rice husks can be used as a potential energy source.



Fig.1 Rice husk in a Rice mill

* Corresponding author. Tel.: +88-01750607736;
E-mail addresses: mdsaulalam70@gmail.com

Already Electricity generation from Rice husk through various technologies is now being used in several developing countries like India, SriLanka, China, and Indonesia etc. In this research, our studied areas were mainly focused on the four districts which are Bogra, Dinajpur, Rajshahi and Rangpur located at the north zone in Bangladesh. The main purpose of this research is to give feasible idea about installation of Rice husk based Steam Turbine power plant in Bangladesh.

2. Methodology

Rice is mainly processed in two sections. One is in Household and other is in Rice mill. Around 5% of total paddy is used as seed for using next growing season and about 70% is processed in local mill and the rest of 25% paddy is processed in rural household level. In this research, Paddy which is processed in Rice mills, was considered the main potential source of Husk supply for electricity generation because household level cannot be considered due to its wide spread localized. Four districts - Bogra, Dinajpur, Rajshahi and Rangpur were selected for collecting data.

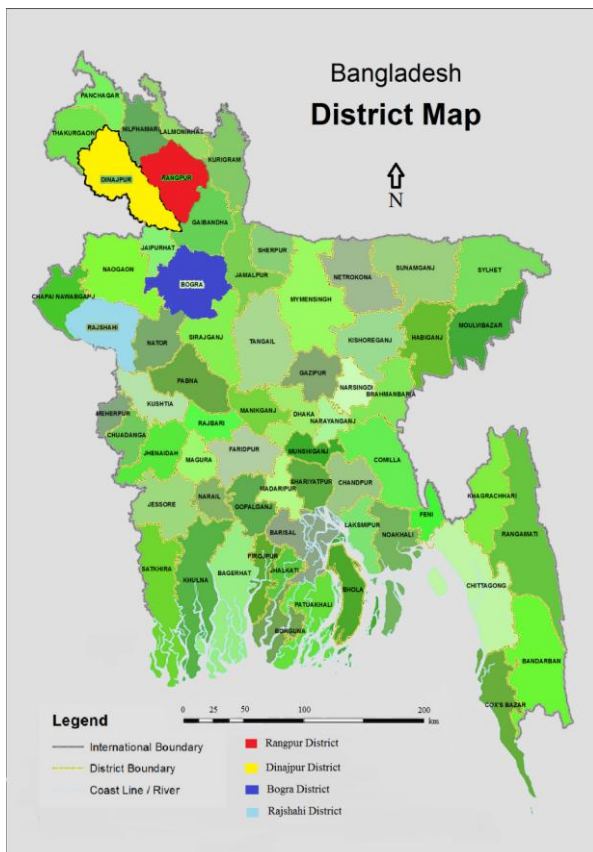


Fig.2 District Map of Bangladesh.

A survey Questionnaire was used to collect the information on annual quantity of Paddy, processed through interviews, observations for the studied Mills and internet sources etc. Over one hundred number of Rice mills were surveyed in this study. Data's of annual Paddy production trend of those districts were collected

from BBS. Various thermo-chemical conversions of Rice husk were studied and total feasible electricity generation from Rice husk mixing with Coal was calculated by using steam turbine Technology. The Rice husk is produced as by-product which can be used as an important source of husk based electricity generated steam turbine plant.

3. Analysis of Rice Husk

Different types of analysis of Rice husk were taken based on various elemental analysis, collected data and finally electricity generation capacity of four districts were calculated which are varied with different color on the map. (I.e. Bogra, Dinajpur, Rajshahi, Rangpur) are given below:

3.1 Proximate Analysis of Rice Husk

Results from proximate analysis are shown in Table 1. Moisture content is one of the important criteria of a fuel for the selection of energy conversion process technology. Thermal conversion requires biomass fuels with lower amount of moisture content. Moisture content less than 10% is suitable for thermal conversion process. As Rice Husk has higher percentage of fixed carbon, volatile content and lower percentage of moisture content, it is suitable for thermal conversion process.

Table 1: Proximate analysis result of Rice husk

Volatile, %	Fixed Carbon, %	Ash, %	Moisture, %
58.90	19.70	13.20	8.20

3.2 Ultimate Analysis of Rice Husk

The percentage of organic elemental contents (i.e. Carbon, Oxygen, Hydrogen, Sulphur etc.) are listed in Table 2.

Table 2 Organic element contents of Rice husk

Carb on, %	Oxyg en, %	Ash, %	Mois ture, %	Hydr ogen , %	Nitro gen, %	Chlo rine, %	Sulp hur, %
39.1	34.70	13.2	8.2	4.59	0.18	0.09	0.04

3.3 District wise Number of Rice Mill

Total Rice Mills in four studied districts are given below [1]:

Table 3 Number of Rice Mills

Bogra	Dinajpur	Rajshahi	Rangpur
3781	1806	1052	1325

3.4 Elemental Analysis

Different elements of Rice Husk are given below [2]:

Table 4 Elemental Analysis

Element	Mg	Si	P	Ca	Cr	Mn	Fe	Cu	Zn	As	Hg	K	Pb
Rice Husk, mg/Kg	0.55	6.66	43.13	570	997.33	302.04	2127	210.76	38.23	0.76	0.98	2395	32.89

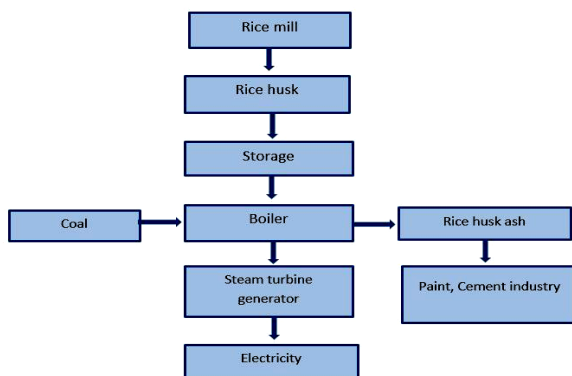
3.5 Electricity Generation Capacities

Estimated electricity generation capacities based on Rice husk as fuel by using Steam Turbine Technology in studied areas are given below:

Table 5 Electricity Generation Capacities

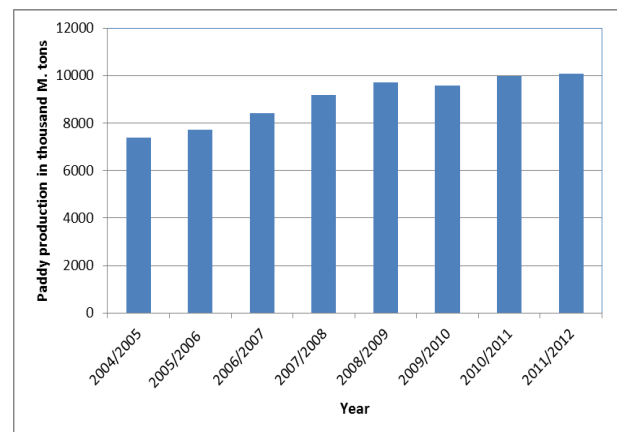
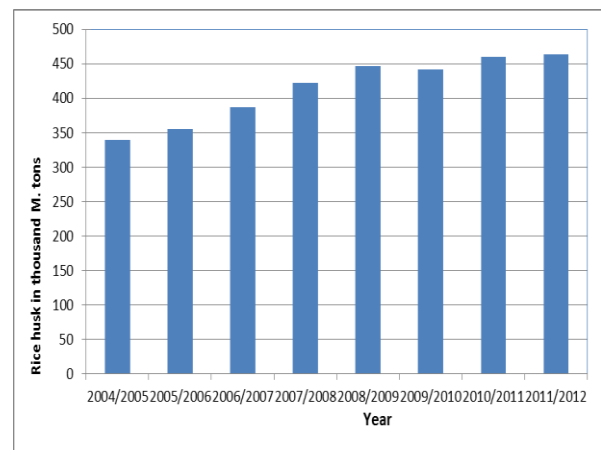
Rice Processing District	Available rice Husk in Thousand M.tons	Electricity Generation by using Steam Turbine Power Plant, kW
Bogra	59.49	5270.88
Dinajpur	89.92	7863.93
Rajshahi	149.25	12718.13
Rangpur	165.41	14095.18
Total =	464.07	39948.12

Husk supplies from Rice mill is not uniform quantity throughout the year. The Husk supply is surplus so that the husk is leftover after consumption and sometimes the husk supply is deficit than needed. By storing husk by uniform amount it can be used to steam boiler in deficit months. Electricity generation from Rice husk depends on availability of husk and its thermal conversion technology. In this research steam turbine technology was used. For steam turbine power plant consumption of Rice husk is 1.3 Kg per KWh as reported by Singh [3]. Total potential power capacity in studied districts is estimated as 39948.12KW.

**Fig. 3:** Block Diagram of power generation from Rice husk.

4. Result Analysis

Over last 8 years there has been an increasing trend of Paddy production as well as Rice husk production. So, power generation from Rice husk by using Steam Turbine Technology is steadily increasing day by day. These analysis are shown in figures given below. Figure-4, Figure-5, Figure-6 represent the trend of Paddy production, Rice husk, estimated energy production respectively from 2004 to 2012. So, it can be assumed that power generation from Rice husk will increase in upcoming future years and Rice husk will add a remarkable amount of electricity in national grid of Bangladesh.

**Fig. 4** Available Paddy production during 2004 to 2012**Fig. 5** Available Rice husk during 2004 to 2012

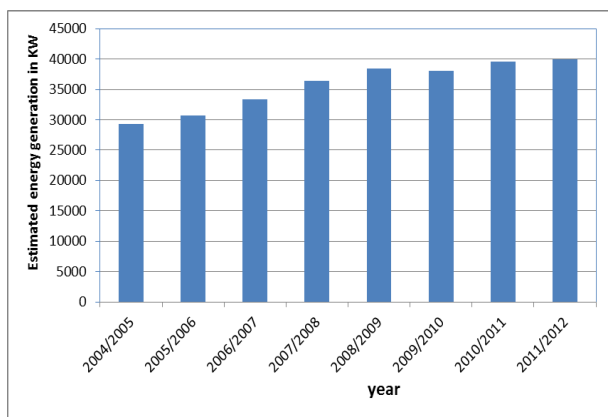


Fig. 6 Estimated energy generation by using Rice husk during 2004 to 2012

5. Environmental Impact

Fossil fuels can cause serious environmental impacts such as global warming, greenhouse effect by CO_2 and acidification by SO_x and NO_x [4]. Combustion of fossil fuel can cause NO_x emissions when the combustion temperatures are higher than 1000°C [5]. In addition to the environmental problems, impact of fossil fuels is an important economic issue for Bangladesh. So, it is necessary to focus on identifying suitable renewable sources for instance biomass. Biomass fuel can be used for reducing greenhouse effect because trees absorb CO_2 as they grow and these carbons are released from biomass combustion process. Since biomass contains a little amount of sulphur compared to coal, it is also expected that there will be lower SO_x emissions [6]. Rice Husk burnt in boilers and produces Rice Husk ash as a residue which is a waste by product of Rice Husk has its different types of application depends upon the physical and chemical properties of it. Rice husk ash has been used widely in various industries such as processing of steel, cement and refractory industries etc. [6]. If Rice husk ash is managed properly then it will be known as a beneficial environmental friendly biomass fuel.

6. Discussion

Rice Husk is a Carbon-neutral and renewable source of energy which reduces the emission of greenhouse gases to improve local environmental conditions. The use of Rice Husk fired in boilers for the generation of electricity, has already been applied in many developing countries throughout the world. Power generation from Rice Husk is modern use of this waste material. This research results in concluding that around 39.5MW generation capacity Steam Turbine plant can be installed in the selected districts to produce electricity from Rice Husk. From this research it is found that the installed capacity is increasing from the year 2004 to 2012. So, it can be said that the installed capacity will increase in upcoming years by increasing Paddy as well as Rice Husk production and remarkable amount of electricity will be added in national grid of Bangladesh. One major constraint raised a question about availability

of Rice husk throughout the year. In Bangladesh Rice Husk is mainly used for preparing briquette fuel as an alternative to wood fuel. The major portion of Rice Husk is being consumed for briquette preparation and moreover, Rice husk is only available during crop season. If total produced Rice husk are collected and stored sincerely then the amount of electricity generated from Rice husk will be sufficient to meet the electricity demand for Rice processing purposes, irrigation process and minimization of load-shedding in studied districts. Similarly, more power generation can be possible if this process is applied throughout the country. It is financially possible to establish the Steam Turbine plant near the area where a large amount of Rice mill resides. Load-shedding is likely to have major influence over the profit of the Rice mills. So, owners of various Rice mills will be happier to have a continuous supply of electricity. More electricity generation will be helpful to stabilize irrigation process in Bangladesh. A small generation of 300KW electricity can run thirty two-cusec pumps; each with 10KW/hour electricity consumption can draw 7000Cft water from underground [7]. For the sustainable utilization of this biomass energy in Bangladesh, the governmental authority like Ministry of Power and Energy needs to inspire confidence and provide incentives for local business to invest in technologies for utilization of Rice husk potential.

7. Conclusion

Bangladesh research and technical institutions should be encouraged and supported to research further into these areas and support for local innovations. These initiatives can make Rice husk as a potential environmental friendly, secure energy source to minimize the fuel consumption especially coal and add remarkable electricity to national grid of Bangladesh. Lacking experience in this sector can be overcome by gaining confidence and learning from the experience of other countries like India, Thailand, and China etc. where already this sector is better established.

NOMENCLATURE

BBS	: Bangladesh Bureau of Statistics
BPDP	: Bangladesh Power Development Board
MT	: Metric Tons
Cft	: Cubic foot
MW	: Mega Watt
KW	: Kilo Watt
KWh	: Kilo Watt hour

REFERENCES

- [1] Bureau of statistics, Ministry of planning, Bangladesh, "BBS Statistical yearbook of Bangladesh", 2012(32th Edition).

- [2] Savitri Garivait, "Physical and chemical properties of Thai Biomass Fuels from Agricultural Residues", 2nd joint International conference on Sustainable Energy and Environmental, Bangkok, Thailand, 1-23 November 2006.
- [3] Singh, R.I "Combustion of Bio-mass in an Atmospheric Fbc: An Experience & study", International Conference on Advances in Energy Research Indian Institute of Bombay, India, December 12-15, 2007.
- [4] Streets,D.G. and waldhoff S.T, "Greenhouse – gas emission from biofuel combustion in Asia", Energy 24:841-855.1999.
- [5] Rafaschiere, A., Rapaccini,M.and Manfrida,G., "Life cycle Assesment of electricity production from poplar energy crops compared with conventional fossil fuels", .Energy Conversion & Management 40:1477-1493, 1999.
- [6] Kaltschmitt, M., Reinhardt,G.A and Stelzer,T., "Life cycle Analysis of biofuels under different environmental aspects", Biomass and Bioenergy.12(2):121-134, 1977.
- [7] Arif Md. Walliullah Bhuiyan, "An improved method to generate Electricity and precipitated silica from Rice Husk perspective in Bangladesh", International Journal of Environmental Science and Development, vol. 2, No. 4, August 2011.