International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-03, Issue 01, Apr 2017

Rice Husk Based Power Generation in Jalpaiguri District

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Abstract : In this present investigation potential of power generation from rice husk in Jalpaiguri district of West Bengal, India has been considered based on paddy production and rice husk output in each of the blocks of the district. The concept and merits-demerits in rice husk based power generation are outlined. It has been shown that apart from supplying needed electricity to all the registered rice mills of the district, the rice husk based power can easily serve Jalpaiguri city along with other areas over the year. This type of study based on rice husk utilization for power generation in Jalpaiguri is indeed a new one.

Keywords — Rice Husk, Jalpaiguri district, Power Generation, Gasification, Combustion.

I. INTRODUCTION

Jalpaiguri district is a district of the Indian state of West Bengal. It is situated between 26° 16' and 27° 0' North latitudes and 88° 4' and 89° 53' East longitudes. The district has an area of 3044 km². The district, at different locations of its border, is surrounded by international borders of Bhutan and Bangladesh apart from Darjeeling, Alipurduar and Coochbehar districts of West Bengal. Jalpaiguri falls in the monsoon climate zone of South-eastern Asia. May is the hottest month and January is the coldest. Rainy season persists for about four months. The annual average rainfall is 3160mm [1]. The entire topography is crisscrossed with rivulets, rivers like Teesta, Torsa, Jaldhaka, Raidak, Dyna, Neora, Sankosh etc and hills. The rivers make the land fertile suitable for agriculture in some areas. Soil of most other areas vary from fine loamy to coarse loamy containing good quantity of sand with soil which require more irrigation and watering for proper cultivation. Jalpaiguri district is composed of two sub-divisions, namely Jalpaiguri sadar subdivision and Mal Subdivision .There are seven blocks in the district. According to the 2011 census, the district has a population of 3,869,675 [1].

II. PADDY PRODUCTION IN JALPAIGURI DISTRICT

Jalpaiguri district produces about 2.5% paddy of total production of West Bengal. The below table shows the area and production statistics of the different blocks of the district. In the raw paddy normally rice weighs 63%, Rice husk weighs 20%, Bran weighs 5%, Broken Rice about 5%. There is about 7% wastage comprising of the straw stones mud and sand particles.

Table 1: Paddy cultivation area in Jalpaiguri District (2015-2016) [2]

Sl. No.	Name of Block	Area (Hectare, Ha)	Production (MT)
1	Jalpaiguri Sadar	25500	98819
2	Rajganj	36816	183517.9
3	Maynaguri	25980	110073.1
4	Dhupguri	28015	96014.2
5	Malbazar	15855	69112.88
6	Matiali	5003	16526.8
7	Nagrakata	5297	18150
TOTAL		**142466**	**592213.88**

III. RICE HUSK BASED POWER GENERATION - CONCEPT

Power generation in India mostly comes through fossil fuel burning, particularly by coal burning, which is not an environment friendly option. Again, coal in India is degrading day by day for which India is now importing coal at an increasing rate at the cost of its foreign currency reserve. Rice being the staple food of our country as well as the crop with highest land area under cultivation, rice husk (RH) generated along with rice in paddy processing is found to have a significant eco-friendly potential in power generation. Rice husk is converted to energy using different technologies such

as direct combustion, co-firing, gasification, pyrolysis, and anaerobic digestion. However, the two most proven and common technologies are the direct combustion and the gasification. Most of today's biomass power plants are direct-fired systems where the biomass fuel is burnt in a boiler to produce high-pressure steam, which is used to power a steam turbine driven power generator[3] . Rice husk based power plants are now coming up in slow pace at different locations of our country [4, 5]. But like many districts, there is no rice husk based power plant in Jalpaiguri district. Using rice husk as a fuel source has certain advantages as well as certain bottlenecks as outlined below.

Table 2: Paddy cultivation productivity in Jalpaiguri District (2015-2016) [2]

Sl. No.	Name of Block	Productivity (kg/Ha)	Rice (MT)	Rice Husk (MT)
1	Jalpaiguri Sadar	3875.255	62255.97	19763.8
2	Rajganj	4984.733	115616.3	36703.58
3	Maynaguri	4236.839	69346.05	22014.62
4	Dhupguri	3427.243	60488.95	19202.84
5	Malbazar	4359.059	43541.11	13822.58
6	Matiali	3303.378	10411.88	3305.36
7	Nagrakata	3426.619	11434.5	3630
TOTAL		**4156.878**	**373094.8**	**118442.8**

IV. PROS AND CONS OF USING RICE HUSK AS A FUEL FOR POWER GENERATION

Pros

- It is environment friendly and meets state and central pollution control norms.
- Rice husk is easily available at rural level.
- Easy storage and handling facility.
- It is a decentralized power generation source. Relevant technology is available and operation is quite easy.
- It helps in employment generation at local levels.
- Eligible for Government capital subsidy.
- Eligible for preferential tariff for power export to state grid.
- Rice husk is carbon neutral and hence contributes to green house gas reduction
- Rice husk power plants are also eligible for carbon credits under Kyoto Protocol [6].
- Silica is obtained as a byproduct and is used in glass, ceramics and cement industries.

Cons

- In the Rice husk gasification process the gas produced contains certain impurities like the tar, ash particles and dust which need to be cleaned before using in the gas turbine. The gas cleaning is an extra process and investment in the rice husk based power generation.
- Other obstacles in using Rice Husk based power generation sources are related to the attitudinal barriers of the investors, lack of promotional awareness from governments end and lack of availability of ease loan at certain situations.
- There is insufficient availability of skilled people for ready maintenance and trouble shooting of the rice husk based power plants at local level to minimize shut down hours in case of plant failures..
- Big power generation with rice husk is normally not feasible in a locality and Rice husk based power plants are captive plants utilized at local decentralized manner.

V. RICE HUSK BASED POWER GENERATION PROCESS

A. Gasification

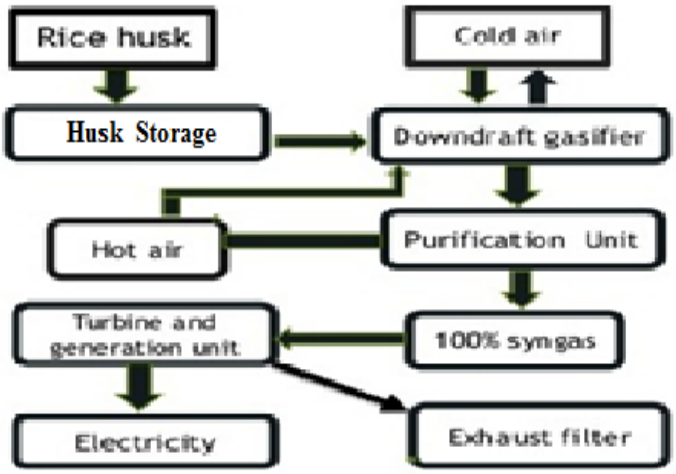

Fig 1: Block Diagram of Electricity Generation from Rice Husk

The process starts from the rice husk storage where the rice husk is put for the process. It is a reservoir of rice husk. After preserving there, the rice husk is conveyed to the gasifier where it goes through certain chemical reactions to produce syngas. There are many gasifiers available in the market having respective merits and demerits. The cheapest among these gasifiers is downdraft gasifier and this gasification chamber produces a product gas with low tar content. The biomass fuel like rice husk is fed at the top of the reactor/gasifier. Then as the fuel moves downward, it reacts with air (the gasification agent).Normally a blower supplies the needed air for the reaction and then the air is converted into combustible producer gas through a complex series of reactions like oxidation, reduction, and pyrolysis.

The produced syngas i.e., producer gas coming from the gasifier usually contains contaminants including dust, ash, coke, tar etc. The contaminants are removed from the gas by

purification system and then the purified syngas is fed to the combustion chamber. In the combustion chamber, compressed air from compressor is fed and the syngas-compressed air mixture is combusted. The flu gas thus generated is expanded through gas turbine, which is kept coupled with generator, to produce electricity. It is suggested to use a smart exhaust filter system which will downsize the emission of CO_2 and other emission components in the air [7].The block diagram of this gas turbine based power generation system is depicted in Fig 2.

Apart from the gas turbine route power generation, the clean syngas can be used for running diesel generators in dual fuel operational mode(i.e., using syngas and diesel oil as fuels) to produce electricity.

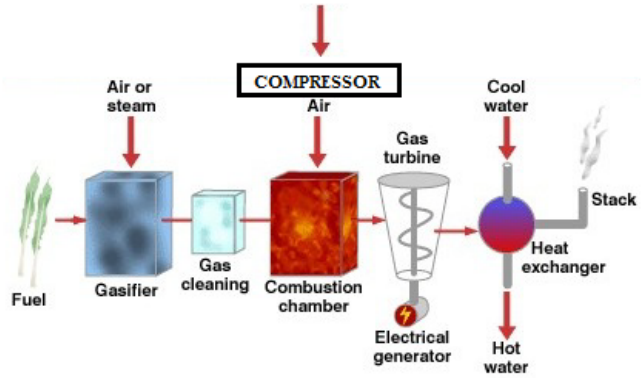

Fig 2: Block diagram of Gas turbine based power generation

B. Direct Combustion

In the direct combustion system, Rice Husk is burned to generate a hot flue gas which is directly fed into a boiler to generate steam. The steam can be used to drive steam turbines to generate electricity or can be used in industrial purposes and space heating. The overall rice husk based plant efficiency with direct combustion method varies from 20 to 30% [8]. The efficiency depends on a number of factors including moisture content of the biomass, combustion air distribution and amounts, burning technology, operating temperatures and pressures, fuel feed handling, distribution, and mixing, and furnace retention time [9]. A block diagram of Direct Combustion method is shown in Fig 3.

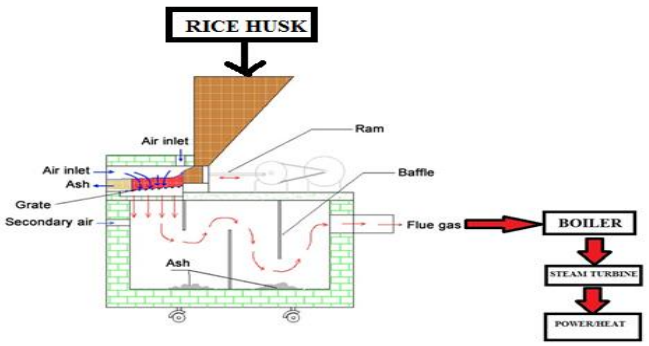

Fig 3: Block diagram of Direct Combustion based power generation

VI. POTENTIAL OF RICE HUSK BASED POWER GENERATION IN JALPAIGURI DISTRICT

Amount of Rice Husk generated in the district: 118442.76 Tons per year =118443 Tons per year approx.
Considering the total rice husk to be used for centralized power generation:

- Amount of heat generated from the rice husk considering 95% [10] combustion efficiency and Calorific value of 13.33 GJ/ Tonne
  =118443*0.95*13.33
  =1499902.9GJ/Year = 1499903 GJ/year
- Considering about 30%[8] of the heat will be converted to electricity:
  =1499903*0.30
  =449971 GJ/Year=449971000 MJ/Year
- MJ to Mwh
  449971000/3600=124992Mwh/Year
  = 124992000kWh/Year
- Considering the power plant operating 350 days a year and 24 hours
  =124992 / (350*24) = 14.8 MW≅ 14 MW

Considering the above data it can be concluded that a 14MW Rice husk based power plant can be set up in Jalpaiguri District which will be running for 24 hours and 350 days a year.

Also considering Rice Husk ash content is 22%,Therefore total ash available will be = 22% of 118443 MT= 26057 MT yearly. This ash is one excellent potash fertilizer which is used to produce compound fertilizer. Also ash contains silica which can be used in glass making industry.

Also the tar collected in the purification process of syngas for Gas turbine/I.C engine based power generation systems can be sold as chemical materials and also can be mixed with coal to improve calorific values apart from other uses.

VII. UTILISATION OF POWER OBTAINED FROM RICE HUSK SOURCE IN JALPAIGURI DISTRICT.

The demand of electricity in Jalpaiguri District is 20000000 kWh monthly (average) = 20000000 *12 =240000000 kWh yearly and the demand in Jalpaiguri city is 5250000kWh monthly i.e., =5250000*12=63000000 kWh yearly [12] .The below figure shows the power generation capacity of different blocks of Jalpaiguri district.

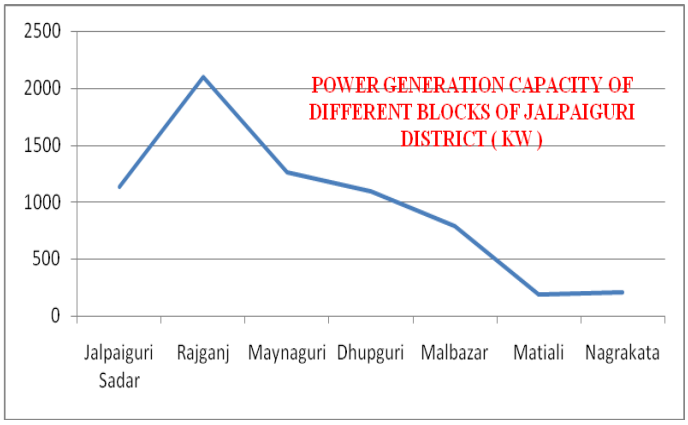

Fig 4: Power Generation Capacity in different blocks of Jalpaiguri District.

Amount of electricity consumed by the various rice mills in the seven blocks of the district [13]

Jalpaiguri Sadar: 2489425 kWh (Approx) Yearly
Maynaguri: 728799 kWh (Approx) Yearly
Rajganj: 1391103 kWh /Year (Approx) Yearly
Dhupguri: No Rice Mill
Matiali: No Rice Mill
Nagrakata: No Rice Mill
Malbazar: No Rice Mill

[Note: Above data are for registered rice mill, there are some unregistered rice mills of different capacities in the different blocks of the district.]

Gross total power required by the rice mills: 4609327 kWh =4609.32 = 4609 MWh/Year
Therefore after supplying power to the Rice Mills, amount of units that can be supplied to the Grid =120383Mwh/Year =120383000kWh /Year.

Now this power can easily meet up the entire demand of Jalpaiguri City. Even after catering total power demand of all the rice mills of the district as well as the Jalpaiguri City further 57,382,673 KWh power can be fed to grid on yearly basis.

VIII. CONCLUSION

In the present investigation rice husk based power generation potential in the Jalpaiguri district of West Bengal is determined considering authentic data of paddy production in the district. It has been shown that there are a good number of reasons to go for rice husk based power generation in the district. It is also shown that rice husk based power generation potential in the district can easily serve all the power demands to run all the registered rice mills of the district as well as total power demand of Jalpaiguri City. Even after that a huge amount of power can be fed to commercial grid. Estimation of rice husk based power generation potential is a new type of research endeavor for Jalpaiguri district.

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