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Generation of Electricity from Paddy Stubble

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Abstract
In Punjab,agricultural waste is major issue in months of Oct-Nov. Due to burning paddy stubble is the complete wastage of biomass and cause serious climatic impact on environment and also on health of people. Annually about 180 lakh ton paddy stubble is left in the fields. Paddy stubble can be potentially used as fuel for electricity generation in Punjab as paddy stubble has calorific value of 3000 Kilocalorie/Kg.A total of 7.7 × 10^6units of electricity is generated from a 20MW biomass plant. To counter stubble burning issue in Punjab biomass plants needs to installed in the state. Moreover, biomass plants are required for increasing electricity demand in the state. This paper explains the technology behind the working of biomass plants and the cost estimation for installing such plants.

Keywords:*Paddy stubble, Biomass energy,Agriculture waste, Vibrating-grate boiler, Sustainable energy, Environmental impacts, Alternative fuel.*

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I. INTRODUCTION

InPunjab and Haryana region, stubble burning has been a major concerning region. Stubble burning is the method of burning rice crop wastage after harvesting to sow wheat during the month of October-November. It is the major cause of air pollution during the months of September to November in north-western part of Indian subcontinent.

Due to increasing vehicular facility day by day, which contributes to major pollution percentage, the addition of stubble burning make it even worse. Crop residue is the major problem of concern after harvesting the crop and the easiest and cheapest solution for it is burning it in-situ. It is due to the fact that there is limited tap gap for sowing of wheat crop. Due to improper burning, stubble burning contains harmful gases like carbon monoxide (CO), methane (CH4), and volatile organic compounds. These pollutants, in atmosphere contributes to human degrading health status and climatic effects such as smog.

Moreover, stubble burning reduces the fertility of soil and disturbs the food chain by loss of microbes in the soil. Due to increasing area under rice cultivation, stubble burning will rice during coming seasons but this problem needs to be resolved to avoid catastrophic effects[1].

Solutions:

- Happy Seeder for direct sowing of wheat without stubble burning.
- Straw baler- to compress crop residue into compact bales and moving them out of fields.
- Super-Seeder: combination of rotary tiller & seed planter[2].

This paper will explain the method of utilizing rice stubble in generation of electricity through biomass operations and contribution towards sustainable energy.

II. BACKGROUND

Sukhvir-Agro energy limited, is located at village SedhaSingh Wala, District Bathinda Punjab. The main aim of the project is the prevention of stubble burning in Bathinda region and adjoining districts by generating electricity from biomass on sustainable basis.

The main project covers area of 25 acre including main electricity generation unit 2 months of raw material storage capacity. The plant capacity is 20MV and it operates 24 hours a day under normal conditions. Plant is connected to 220kv Bajakhana grid through a 66kv transmission line. Paddy bails are used in economical manner as fuel for heating and power generation. A total of 15-20 km of agricultural area is covered by one storage dump for storing paddy bails. There is a total of 7 storage dump across its adjoining districts with total area coverage of 150-140 sq km.

Fig 1. Paddy bails storage

Details of the project were collected from project engineers and are presented in Table 1.

CONTENT	DATA
Raw material	Paddy bails
Plant capacity	20 Mega-Watts
Main plant area coverage	25 Acre
Number of storage dumps	7
Area coverage of whole plant	105-120 Sq Km
Daily raw material consumption	500 Ton
Yearly raw material consumption	2,00,000 Ton

Table 1. Plant data

III. METHODOLOGY

Methodology explains the type of technology used in generation of electricity from agriculture waste material like paddy stubble through sustainable means.

A. Vibrating Grate boiler

A vibrating grate boiler technology was developed in Denmark and was recently launched in India and can be used for firing any kind of biomass. It is a new Denmark based technology allows the plant to fire a wide range of fuels with less fuel preparation and handling, and mainly avoid the energy-intensive process of briquetting and pelletization that adds to the power generation cost.It is advantageous because of vibrating grate as the grate of a steam boiler supports the solid fuel in furnace. It accommodates the biomass of every density, but the moisture content of fuel should be within 15-20%.Paddy bails before being conveyed to combustion system, are first passed through a bale string cutter and dosing screw to reduce its size for achieving the complete combustion of biomass fed into boiler [3].

CONTENTS	DATA
Type	Vibrating grate
Manufacturer	Thyson Kkrup
Technology	Denmark
Design	Babcock & Wilcox (B&W)
Rating	50 ton per hour steam generation
Average steam to fuel ratio	4-4.5
Efficiency (max)	85%

Table 2. Boiler information

B. Turbine

A reaction turbine is used to convert mechanical energy of steam into electrical energy. A steam turbine is driven with high temperature and pressure steam produced by vibrating grate boiler. The high-pressure steam is expanded onto the blades of turbine due to which turbine rotates.This takes place due to conversion of steam energy to mechanical energy that further drives the alternator connected to it through gearbox.

Table 3. represents the rating of turbine used in generating electricity:

CONTENTS	DATA
Rated power	20.85 MW
Rated speed	6800 rpm
Trip speed	7480 rpm
Live steam pressure	93.00 Ata
Live steam temperature	535ºC
Exhaust steam pressure	0.09 Ata
Type	Reaction turbine

Manufacturer	Siemens

Table 3. Turbine ratings

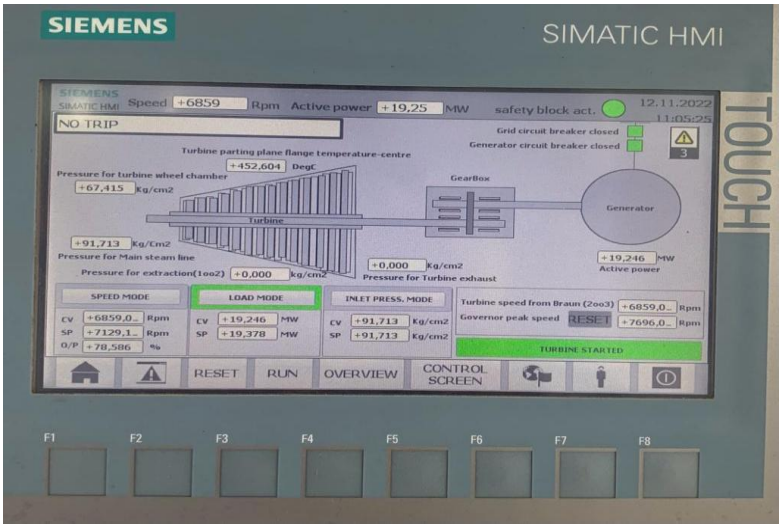

Fig 2. Turbine supervisory

C. AC GENERATOR

AC generator receives energy from turbine through gearbox in form of mechanical energy and convert it to electrical energy. In SAEL, a 25000KVA output AC generator is in operation.

Table 4. represents the rating of generator used:

CONTENTS	**DATA**
Output	25000 KVA
Standard	IEC 60034
No. of phases	3
No. of poles	4
Voltage (AC)	11000 V
Current (AC)	1312 A
Frequency	50 Hz
Speed	1500 min^{-1}
Limiting speed	1800 min^{-1}
Power factor	0.8

Table 4. AC generator ratings

The generator is operated with brushless excitation system. Brushless excitation system technology is used for providing field current to the generator without the use of slip rings and carbon brushes. It avoids the losses due to contact resistance of carbon brushes. Also, for initial startup of generator we do not need any external power supply.

Table 5. show the rating of AC exciter used:

CONTENTS	**DATA**
System	Brushless excitation system
Output (DC)	181 KW
Voltage (DC)	279 V
Current (DC)	650 A
Excitation voltage (DC)	111 V
Excitation current (DC)	11.2 A
Class of insulation	F

Table 5. AC exciter rating

IV. ANALYSIS

Analysis is carried out by studying different costs involved to run a 20MW biomass plant. These costs are: capital cost, operating cost, Raw material cost and cost of electricity[4].

Cost of electricity:
The cost of electricity generation involves three main components capital cost, operating and maintenance cost and the cost of raw material.
Cost analysis of 20MW project has been carried out with help of SAEL engineers. Different type of costs are provided in Table. 6

PARAMETERS	VALUE
Capital cost	Rs. 200 Crore
Cost of raw material	Rs. 180 per Ton
Operating and maintenance cost	Rs. 9,50,000 per month
Rate/unit (electricity)	Rs. 8.92 per unit

Table 6. Cost chart

Total quantity of raw material used	500 ton×30 = 15000 ton per month
Cost of raw material per ton	Rs. 180
Total cost of raw material	Rs. 15000×180 = Rs.27,00,000 per month
Operational and maintenance cost	Rs. 9,50,000 per month
Electricity units generated	7,00,000 units (average) per month
Total selling price of electricity	7,00,000 × Rs. 8.92 = Rs. 62,44,000

Table. 7 Cost Analysis

Total profit per month = Total selling price of electricity – cost of raw material – operational and maintenance cost

Total profit per month = Rs. 62,44,000 – Rs.27,00,000 – Rs. 9,50,000 = Rs. 25,94,000

Total profit per year = Rs. 25,94,000 × 11 months = Rs. 2,85,34,000

V. WASTE MANAGEMENT AND EMISSION CONTROL

In any steam power plant waste-management and emission control becomes major issue due to degradable effects of waste on environment.

Sustainable energy production from biomass is the outmost priority for future references therefore ash and emission gases should be taken care off.

In SAEL, ash produced from boiler is directly loaded into tipper trucks after cooling its temperature with help of water. Ash produced is used as a decompostin nearby fields because of high silica content. Moreover, ash is also used in leveling purposes of construction of new buildings and houses. A check on emission of harmful gases is maintained by back filters or electrostatic precipitator. Major gases released in environment is carbon dioxide (CO2) which is used by trees in photosynthesis.

Fig. 3 Back filter

Fig. 4 Ash management

VI. RESULTS AND DISCUSSIONS

A total of 7.7×10^6 units of electricity is generated from a 20MW biomass plant. A total of 3000kilo calories per kg is generated by rice stubble as compared to 5100 kilo calorie per kg of coal used in conventional power plants. Moreover, thermal power plants require high capital cost as compared to biomass-based plants.As the problem of stubble burning is rising day by day with rise in area under rice cultivation, more such plants are required in every district of Punjab. Increasing demand of fossil fuel has disrupted the sustainability of natural resources therefore, biomass is perfect replacement of fossil fuel for electricity generation.Thus, use of biomass plants has become an outmost priority also for meeting the increasing demand of electricity.

VII. CONCLUSION

On the basis of study carried out, it is concluded that:

- 15000 ton of paddy bails are used per month to produce 7,00,000 KWH of electricity by means of sustainable energy.
- The potential of generating electricity from paddy bails can be enhanced by setting up more biomass plants as only 30% of total stubble produced is used in sustainable purposes and the rest 70% still is being burnt in-situ.
- Cost of generating electricity by biomass plants is approximately rupees 2.5 per unit, hence this technology is more efficient and sustainable for electricity generation than conventional power plants.

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