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Comparative Study of Energy and Environmental Impact of Rice Husk and Bagasse in a Biomass Gasifier

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ABSTRACT: Rapid rate at which fossil and residual fuels are releasing CO_2 into the atmosphere has raised international concern and has spurred intensive efforts to develop alternative, renewable,sources of primary energy.Biomass as the solar energy stored in chemical form in plant and animal materials is among the most precious and most promising alternative fuels not only for power generation but also for other industrial and domestic applications on earth. It provides not only food but also energy, building materials, paper, fabrics, medicines and chemicals. Biomass has been used for energy purposes ever since man discovered fire. It is important to say, that biomass absorbs the same amount of CO_2 in growing that it releases when burned as a fuel in any form. This means that biomass contribution to global warming is zero. In addition, biomass fuels contain negligible amount of sulphur, so their contribution to acid rain is minimal. Over millions of years, natural processes in the earth transformed organic matter into today's fossil fuels: oil, natural gas and coal.

KEYWORDS: fossil and residual fuels, husk,biomass, energy

I. INTERODUCTION

A ENERGY ESTIMATION OF RICE HUSK

To evaluate the energy consumption during the life cycle of rice husk for biomass, gasifier. To find the energy ratio of Rice husk, to calculate the how much of energy input during various process and how much of energy is out. The various input energy involve like Plant nursery, plantation, seed collection, rice husk extraction, biogas production at biomass gasifier, care, safety are the major parameters which are considered as input parameters. Sensitivity analysis is carried out for various parameters such as-[1]

1. Soil type.
2. Rainfall/ground water.
3. Yield.
4. Type of labour input.

Mathematical modelling and analysis of biogas production are primarily based on following stages and sub processes-

1. Rice cultivation.
2. Rice husk extraction.
3. Biogas production.

Following assumption made for evaluation of energy life cycle of rice husk-

1. Rice cultivation starts from field.
2. Planting density of rice plant.
3. No pesticides, insecticides, or herbicides are applied to the crops.
4. The energy is used in creating and manufacturing of the machinery used to assist the life cycle of the biogas production.

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A.A METHODOLOGY AND PROCEDURE

Energy analysis of Rice husk for that 1000 kg of rice paddy. There are some important parameters which shows the major energy inputs such are [6]-

1. Energy imparted in the transportation.
2. Energy of manpower used in whole process.
3. Fuel consumed in conversion of rice paddy to rice husk.
4. Energy involved in the biomass gasifier.

A.B MATHEMATICAL MODELLING FOR VARIOUS PARAMETERS

A.B.A INPUT

Energy imparted in the transportation (E_T) - Energy of transportation involved the fuel consumption and net energy of fuel and some distance factor or constant R which can vary according to distance[1].

$E_{T=}$ specific fuel consumption x density of fuel x calorific value of fuel used x factor of distance

$E_T = V_f \times \rho \times C_V \times r(1)$

Energy involved in process (E_M) - According to fundamental of physiology: a human perspective' by Lureeen Sherwood, the energy expenditure by human worker during normal working 1 MJ/h, low working 0.84 MJ/h, and heavy working 1.2 MJ/h. based on the above, the manpower spent is calculated as follows

$E_M = E(X_1 \times t_1 + X_2 \times t_2)(2)$

Energy involve for conversion (E_C)- Energy required to convert paddy to rice husk with multistage or multipass rice mills. I take 1000kg paddy 5HP diesel set, it consume 1.5 lit diesel in 1 hour and process 300kg in same. Based on the above consumption write a energy consumption equation

$E_C = V_f \times C_V + E_{man} \times t$ (3)

Energy Utilizes at various stages of Gasifier- Energy consumes at various stages of biomass gasifier in terms of two type of reactions called endothermic (positive)and exothermic (negative)

$E_G = E_{exotermic} + E_{endot\ hermic}$ (4)

Total energy input- total energy input is sum of all input energy viz. transportation, man, conversion, at gasifier. It is given by

$$E_{i/p} = E_t + E_M + E_C + E_G \quad (5)$$

A.B.B OUTPUT

Energy containing by Biogas- After the gasification process biogass produced as a final product. now calculate the how much energy in final product, and it was my final energy output.it can be defined as met calorific value of biogass, produced quantity and density

$E_{o/p} = C_V \times q \times \rho$ (6)

A.C. NET ENERGY RATIO

Based on quantification of energy consumption and energy output modelling, the dimensionless parameter named energy ratio has been estimated. It specifies the energy consumed in converting into useful fuel

$R = \frac{E_{o/p}}{E_{i/p}}(7)$

B. ENERGY ESTIMATION OF BAGASSE

To evaluate the energy consumption during the life cycle of bagasse for biomass gasifier. To find the energy ratio of Bagasse, to calculate the how much of energy input during various process and how much of energy is out. The various input energy involve like Plant nursery, plantation, seed collection, bagasse extraction, biogas production at biomass gasifier, care, safety are the major parameters which are considered as input parameters. Sensitivity analysis is carried out for various parameters such as [3].

1. Soil type
2. Rainfall/ground water
3. Yield and
4. Type of labour input

Mathematical modeling and analysis of biogas production are primarily based on following stages and sub processes-

1. Sugarcane cultivation
2. Bagasse extraction
3. Biogas production

Following assumption made for evaluation of energy life cycle of bagasse-

1. Sugarcane cultivation starts from field.
2. Planting density of sugarcane field.
3. No pesticides, insecticides, or herbicides are applied to the crops.
4. The energy is used in creating and manufacturing of the machinery used to assist the life cycle of the biogas production.

B.A METHODOLOGY AND PROCEDURE

Energy analysis of Bagasse for that 1000 kg of bagasse. I take some important parameters which shows the major energy inputs such are-

1. Energy imparted in the transportation.
2. Energy of manpower used in whole process.
3. Energy involve for conversion sugarcane to bagasse.
4. Energy involved in the biomass gasifier.

B.B. MATHEMATICAL MODELLING FOR VARIOUS PARAMETERS

B.B.A.INPUT

Energy imparted in the transportation (E_T)- Energy of transportation involved the fuel consumption and net energy of fuel and some distance factor or constant R which can vary according to distance [4].

$E_{T} =$ specific fuel consumption x density of fuel x calorific value of fuel used x factor of distance

$$E_T = V_f \times \rho \times C_V \times r \qquad (8)$$

Energy involved in process (E_M)- According to fundamental of physiology: a human perspective' by Lureeen Sherwood, the energy expenditure by human worker during normal working 1 MJ/h, low working 0.84 MJ/h, and heavy working 1.2 MJ/h. based on the above, the manpower spent is calculated as follows

$$E_M = E(X_1 \times t_1 + X_2 \times t_2) \qquad (9)$$

Energy involve for conversion (E_C) - Energy required to convert sugarcane to bagasse with sugar mills. I take 1000 kg sugarcane 5 HP diesel set, it consume 1.8927 lit. diesel in 1 hour and process 300 kg in same. Based on the above consumption write a energy consumption equation

$$E_C = V_f \times C_V + E_{man} \times t \qquad (10)$$

Energy Utilizes at various stages of Gasifier- Energy consumes at various stages of biomass gasifier in terms of two type of reactions called endothermic (positive) and exothermic (negative)

$$E_G = E_{exotermic} + E_{endot\,hermic} \quad (11)$$

Total energy input- total energy input is sum of all input energy viz. transportation, man, conversion, at gasifier. It is given by

$$E_{i/p} = E_t + E_M + E_C + E_G \quad (12)$$

B.B.B. OUTPUT

Energy containing by Biogas- After the gasification process biogas produced as a final product. Now calculate the how much energy in final product, and it was my final energy output. it can be defined as net calorific value of biogas, produced quantity and density [7].

$$E_{o/p} = C_V \times q \times \rho \qquad (13)$$

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B.C. NET ENERGY RATIO

Based on quantification of energy consumption and energy output modelling, the dimensionless parameter named energy ratio has been estimated. It specifies the energy consumed in converting into useful fuel

$$R = \frac{E_{o/p}}{E_{i/p}} (14)$$

II. RICE HUSKS AND BAGASSE ENVIRONMENTAL IMPACT

To evaluate the environmental impact of energy production from agricultural residues two study sites were selected: Gasifier Plant for the use of rice husks and RanaSugars Ltd for bagasse Different components of interest are SO_2 and NOx for their contribution to acid deposition; CO, CO_2 for their contribution to global warming and Total Suspended Particles (TSP) for their impact on the environment and role of indicator of combustion and dust removal equipment efficiency [5].The Urja Gasifier Plant is a pilot plant of 500 KW capacity the flue gas generated from the combustion passes through a multi-cyclone and electrostatic precipitator for particulate removal. The emission of the flue gas is not monitored continuously but can be measured by using stack sampling method. Data from the measurement at stack (Temperature = 161°C) indicated that a flow rate of the flue gas is 68 510.8 m3/h for a fuel feeding rate of 12.083 tons/h. The characteristics of the rice husks used at Urja gasifier plant are shown in Table 1.

TABLE.1. COMPOSITIONS OF RICE HUSKS USED AT URJA GASIFIER PLANT AND OF BAGASSE USED AT RANA SUGAR FACTORY

Parameters	Rice Husk	Bagasse
C(% dry weight)	36.23	40.60
H(% dry weight)	5.20	5.10
O(% dry weight)	39.49	32.12
N(% dry weight)	1.15	1.72
S(% dry weight)	0.039	<1.00
Totalmoisture(% a.r)	11.40	52.00
Ash content(% dry weight)	13.90	N.A.

The Rana Sugar Mill is located in Amritsar District; Punjab The mill capacity is 10,000 tons of sugar cane per day during the crushing season. The power plant is situated inside the sugar mill and is of cogeneration type with 2 water-tube boilers of 300 tons/h capacity each. Part of the steam is used in the sugar process and the remaining goes to 2 steam turbines of 5 MW capacities each [2].

TABLE.2. EMISSIONS FROM URJA GASIFIER PLANT AND RANA SUGAR MILL COMPARED TO THOSE FROM POWER PLANTS USING CONVENTIONAL FUELS

Item	Emission(kg/MWh)					
	Rice Husk	Bagasse	Coal	Oil	Gas	Combined
CO_2	-	-	1269.52	812.16	568.88	733.98
SO_2	0.15	0.10	1.77	1.10	0.0002	0.54
CO	0.52	34.64	0.178	0.22	0.187	0.189
NO_2	1.50	1.45	4.56	1.89	1.34	2.35
TSP(Dust)	0.03	16.97	0.021	0.787	0.023	0.023

III. CONCLUSION

The CO_2 emitted during the combustion of rice husks and bagasse is of biomass origin and hence being part of the global carbon cycle, i.e. will be reabsorbed by sugar cane and rice during their growth through photosynthesis.

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Therefore it does not contribute to global warming, and so represents a distinct advantage of biomass-based energy production. but higher than that of natural gas power plant. This result is also expected since bagasse and rice husks have <1% sulfur content (Table 1). Considering this level of emission, the installation of a Flue Gas Desulfurization (FGD) unit is not required for biomass power plant. Similarly, NO_x emission from biomass based power plant is also less than that from coal and oil power plants but higher than that of natural gas one, which is generally equipped with a low NO_x burner or a Denox device for NO_x removal. This result is also expected since combustion temperatures observed in biomass-based power plants are generally lower than 900°C implying that all NO_x stems only from the fuel nitrogen and not from thermal process that uses the atmospheric nitrogen as reactant. Both SO_2 and NO_x contribute to acidification, and in addition, NO_x is involved in photochemical ozone formation as well as nutrient enrichment. Thus, the electricity production from rice husks and biomass can be considered as environmentally more performant than the conventional electricity production on these counts.

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