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Analysis for Possibilities of Energy Resources from Sugarcane Trash

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Abstract:- **The requirement of energy is continuously increasing all over the world and currently major part of this requirement is being fulfilled by the conventional sources of energy. In conventional sources, fossil fuels such petroleum natural gas and coal are widely used for generating electricity. And it is known very well to all that availability of these fuels are limited on the earth and being consumed increasingly. These fuels may not serve the word for ever. Biomass may be alternate fuel to face the scarcity of conventional fuels. This paper is entitled to search the electricity generation by the biomass left in sugarcane field after harvesting cane stalk i.e. cane trash. From the analysis it is found that more than 28 million tones of trash is burnt in the field by the farmers. Uttar Pradesh alone generate 13.23 million tones of trash. And from this amount of trash 823.17 MW (3556 x10^3 MWh) power can be produced in Uttar Pradesh alone. 1.77 million tones of coal is required to produce this amount of energy. And all over India 7645.49x^6 MWh Power can be obtained with trash that is equivalent to 3.8 Million tones of coal**

Keywords: Sugarcane, Trash, Baggage, power & sugar mill etc

I. INTRODUCTION

It is well known to everyone that conventional fuels such as coal, petroleum etc are limited. This scarcity of conventional fuel, forced researchers to search the alternative source of energy to meet the future demand of energy in the form of electricity. Today the concentration is being made toward the renewable energy sources such as wind energy, tidal energy, solar energy geothermal energy, hydropower & energy by biomass. The electricity generation by bagasse is adopted by many sugar mills not only in India but in many countries of the word.

This paper is focused on the electricity generation by biomass of sugarcane trash (cane trash). Electricity production by these sources may be the alternate fuel for boiler and the emission can be easily managed compared to the emission generated by conventional sources.

India produced sugarcane in large amount and having second rank in producing sugarcane next after Brazil. Sugarcane produces mainly two type of biomass i.e Bagasse and Trash.

II. BAGASSE & CANE TRASH:

India is the second largest producer of sugarcane in the word next after Brazil. Total production of sugar cane in India is more than 350 Million tones. The production sugarcane in leading states is tabulated as-

State wise production of sugarcane for session 2014-15

S.N.	Name of state	Production in Million Tones
1	Uttar Pradesh	138.48
2	Maharashtra	81.87
3	Karnataka	41.89
4	Tamilnadu	24.46
5	Bihar	14.13
6	Gujrat	14.06
7	Andhra Pradesh & Telangna	13.15
8	Haryana	7.65
9	Punjab	7.03
10	Uttarakhand	6.13
	Total	348.85

Table1.1

A large agricultural area is occupied by the cultivation of sugarcane. The area under sugarcane cultivation is tabulated as given in table 1.2

S.No.	Name of state	Cultivation Area in lakh Hectares
1	Uttar Pradesh	21
2	Maharashtra	9
3	Karnataka	4
4	Tamilnadu	2.3
5	Bihar	2.1
6	Gujrat	1.8
7	Andhra Pradesh & Telangna	1.6
8	Haryana	1.3
9	Punjab	0.9
10	Uttarakhand	1.2
	Total	45.2

Table 1.2

Sugarcane trash is the dry leaves attached to the can stalks. It remains left in the field after harvesting the cane stalks.

The production of cane trash depends on the age of crop ,soil and weather conditions and the crop variety. Its production is about 14-16 % of the total above ground biomass it is almost 12-16 tones per hectare of dry matter. During the harvesting process around 20-30 % of the trash is carried to mill

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together with cane stalks and 70-80 % of the trash remained in the field. Commonly this left amount of trash is burnt by the farmer in the field. Burning of trash in field releases green house gasses like N_2O, CH_4, CO and CO_2 . About 3 tones per hectare of trash is utilized for mulching for conserving soil moisture and nutrients.

III. LITERATURE SURVEY:

According to the international sugar organization (ISO) ,sugarcane is a highly efficient converter of solar energy, and has the highest energy to volume ratio among energy crops, indeed, it gives the highest annual yield of the biomass of all the species. Roughly 1 tone of sugarcane biomass based on bagasse, foliage and ethanol output- has an energy content equivalent to one barrel of crude oil.

Sugarcane is an energy crop produces the energy equivalent per hectare cropping cycle of 95-114 barrels of crude oil (Botha,2009; Ripoli, 2000; Rein,2007; Krishna, 2002). 60 % of the energy is transported to the mill as the clean cane, 12 % is utilized as fodder (Young internodes and green leaves) and the rest 28 % (trash) is predominantly burnt in the open (Ripoli,2000;Rein, 2007;Krishna, 2002)

Cane trash is a potential fuel with a clorific value ranging from 3845-4375 Kcal/kg on dry basis (Kurt woytuik, 2006) having moisture in the range of 20-30 %.

About 3 tones per hectare of trash is utilized for mulching for conserving soil moisture and nutrients (Ramalingaswam, 1998)

IV. ANALYSIS & CALCULATION:

During the harvesting operation about 12-16 tones per hectares of cane trash is produced. Here the calculation is carried out considering minimum of 12-16 i.e. 12 tones per hectares. 3 tones per hectares is considered for mulching. And it is also considered that 70 % of trash is left in the field and 30 % is taken to the mill together with the cane stalks.

Tabulated analysis is carried out for calculating the amount of trash available for power generation for ten leading state in sugarcane production

Minimum amount of trash produced & Amount of trash for mulching.

S.N.	Name of state	Minimum amount of trash Produced (Million tones)	Amount of trash for Mulching (Million tones)
1	Uttar Pradesh	25.2	6.3
2	Maharashtra	10.8	2.7
3	Karnataka	4.8	1.2
4	Tamilnadu	2.76	0.69
5	Bihar	2.52	0.63
6	Gujrat	2.16	0.54
7	Andhra Pradesh & Telangna	1.92	0.48
8	Haryana	1.56	0.39
9	Punjab	1.08	0.27
10	Uttarakhand	1.44	0.36

Table 1.3

Amount of trash available as source of energy

S.N.	Amount for trash excluding mulching (Million tones)	Amount of trash Carried to mill with can stalk (Million tones)	Amount of trash Left at field after harvesting (Million tones)
1	18.9	5.67	13.23
2	8.1	2.43	5.67
3	3.6	1.08	2.52
4	2.07	0.621	1.449
5	1.89	0.567	1.323
6	1.62	0.486	1.134
7	1.44	0.432	1.008
8	1.17	0.351	0.819
9	0.81	0.243	0.567
10	1.08	0.324	0.756
	Total		28.476

Table 1.5

From the calculation it is found that more than 28 million tones is burnt in the field by the farmers. Uttar Pradesh alone generate 13.23 million tones of trash. This is a large amount to utilized by the mills through co-generation plant for the production of electricity.

Cane trash has the following properties

Calorific value	3845-4375 Kcal/kg
Moisture content	20-30 %
Bulk Density	50-65 kg/m^3
Burning temperature	600^O C – 800^O C
Gases released while burning	N_2O, CH_4, CO and CO_2

For analyzing the following input parameters are taken

1	Turbine inlet temperature	500^{O}C
2	Boiler Pressure	60 bar
3	Condensers pressure	.06 bar
4	Turbine efficiency	90%
5	Boiler Efficiency	75%
6	Pump Efficiency	95%
7	C.V of fuel	3845 kJ/kg

Considering co-generation plants will work in off-session for six months

Total amount of trash produced in Uttar Pradesh =13.23 Million Tones

Plant operational period = 6 months

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Designed amount of trash consumed $= \frac{13.23 \times 10^6}{6 \times 24 \times 30}$

= 3062.5 tones/hour

From the steam table

State	Temp.(° C)	Press. (bar)	Enthalpy (kJ/kg)	Sp. volume (m^3/kg)
1	500	60	3422.2	0.0567
2	-	0.06	2205.01	23.74
3	-	0.06	151.5	0.001006
4	-	60	157.53	-

Table 1.6

For state 2 assumed dryness friction x=.85 and the enthalpy an sp. Volume is calculated with the formula $h_2 = h_f + xh_{fg}$ & $v_2 = v_f + xv_{fg}$.

T-S Diagram of Rankine cycle

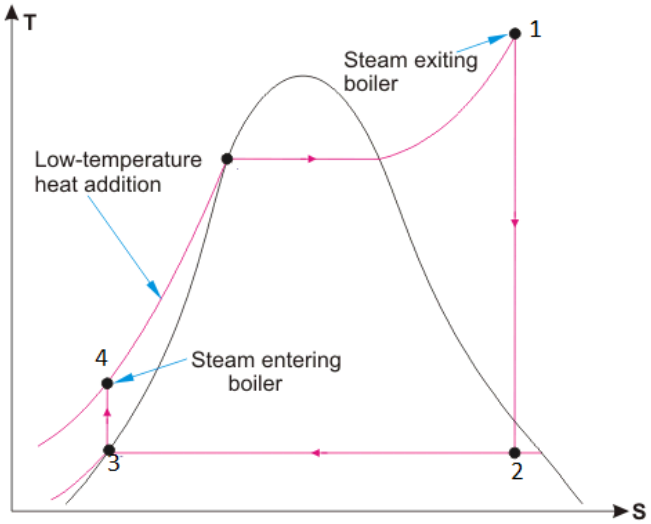

Figure 1.1

Process (1-2)

Turbine output in kJ/kg $= \eta_t(h_1-h_2)$

= 1095.47

Process (2-3)

Energy rejected from the condenser in kJ/kg $= h_2-h_3$

=2053.52

Process (3-4)

Pump input in kJ/kg $= (v*(P_1-P_2))/\eta p$

= 6.34733

Process (4-1)

from

Pump input $= v(P_1-P_2) = h_4-h_3$

$h_4 =$ 157.53 kJ/kg

heat added in kJ/kg $= h_1-h_4$

= 3264.67

Amount of steam generated:

Heat added = η_t *C.V of fuel *mass rate (t/h)

$m_s(h_1-h_4) = \eta_t$ *C.V of fuel *mass rate (t/h)

m_s=2705.17 tones/h

Total output of the plant =turbine output x mass rate of steam

= 823.17 MW

V. RESULT & DISCUSSION:

From the analysis it is found that alone Uttar Pradesh is able to produce 823.17 MW power for six month which is equivalent to 3556 $x10^3$ MWh.

Proposed Capacity of Power produced by cane trash for leading state are as following-

S.N	Name of state	Total Capacity in MW	Total Power Generated (MWh)
1	Uttar Pradesh	823.173	3556106.5
2	Maharashtra	352.788	1524045.6
3	Karnataka	156.795	677353.62
4	Tamilnadu	89.597	387059.21
5	Bihar	82.1306	354804.28
6	Gujrat	70.3088	303733.96
7	Andhra Pradesh & Telangna	62.7179	270941.45
8	Haryana	50.3983	217720.81
9	Punjab	34.8433	150523.03
10	Uttarakhand	47.0384	203206.09
	Total	1769.79	7645494.6

Table 1.7

This table is formed on the basis of sis month operation of the plant. it can be observed from the table that total 1769 MW power can be generated from the trash left in the field after harvesting process. in other word total 7645.49 $x10^6$ MWh energy can be produced in India with the cane trash.

For power generation with trash it is not required to set-up plant separately but it need to redesign co-generation plant of regional sugar mill to enhance the capacity of the plant.

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VI. CONCLUSION & SUMMARY

Uttar Pradesh alone can produce power with rating 3556 $x10^3$ MWh that can be generate with 1.778 million tones of coal. And all over India 7645.49x^6 MWh Power can be obtained with trash that is equivalent to 3.8 Million tones of coal.

There is a good scope to generate power from cane trash. But there are several challenges to do so. Fist and major problem is to collect trash from the field and transport to the mill. Low bulk density of the trash increases the cost of transportation per tone.

Manual collection and transpiration may be very costly due to bulky nature alternate solution may the baling of the trash and then transported it will increase the density.

Now it required to research to develop new techniques and machineries for the same.

Appendix

h_f = Specific enthalpy of saturated liquid ,kJ/kg

h_{fg} = Specific enthalpy of evaporation ,kJ/kg

hg = Specific enthalpy of saturated Vapur , kJ/kg

v= specific volume, m^3/k

x= dryness friction

$^{\eta}t$ = efficiency of turbine

$^{\eta}b$ = efficiency of boiler

$^{\eta}p$ = efficiency of turbine

T= temperature

S= Entropy

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