AN EXPERIMENTAL STUDY OF BIOMASS FUEL MADE BY A COMBINATION OF SUGARCANE BAGASSE, SAWDUST AND PAPER WASTE

Shreya Shukla[1], Savita Vyas[2]

[1]Department of energy and environment management, Rajiv Gandhi Proudyogiki Vishwavidyalaya, Madhya Pradesh, India.
[2]Assistant professor, department of energy and environment management, Rajiv Gandhi Proudyogiki Vishwavidyalaya, Madhya Pradesh, India.

Abstract

For making biomass fuel i.e. for making alternative fuel for coal or other conventional sources of energy it is important to find certain parameters. Calorific value is the most important property of a fuel whereas moisture content, ash content also significantly affects the performance of fuel. Here, the work focuses on making a biomass fuel with the combination of three materials i.e. sugarcane bagasse, sawdust and paper waste. These raw materials are selected on the basis of their calorific value, ash content, moisture content, easy availability and its cost.

*In sugar mills, major by product is sugarcane bagasse and therefore we used 50-60% of sugarcane bagasse for making fuel, paper waste is easily available and also its property is that it increases the calorific value if it is used 10-20% and if it is further increased then calorific value starts decreasing, sawdust is used 20-40% . Its calorific value is also high. **MINITAB SOFTWARE** is used for the design of experiment. Moisture content is determined with the help of **DIGITAL MOISTURE ANALYZER**. Ash content is determined by using **ELECTRIC COIL HEATER** and **MUFFLE FURNACE**. Calorific value is calculated by using **MODIFIED DULONG FORMULA**.*

From tests it is obtained that moisture content is between 8%-12%, ash content is in the range of 4%-8% and calorific value is between 2800 Kcal/kg – 3000 Kcal/kg. Now this fuel is compared with coal. The main point of view for making this bio fuel is that it can be efficiently used for co generation with coal which results in less consumption of conventional fuels which will have large no. of benefits like first and foremost is that coal is conventional and non renewable source of energy so its consumption will be reduced, pollution will be less, emissions of GHG like SOX, NOX, CO_2 will be reduced, cost of plant is reduced, ash content is the main drawback of thermal plants, handling of ash is very big problem of thermal power plants and if 50% use of coal is reduced then ash is reduced and last raw materials will be used efficiently.

Key words: *Sugarcane bagasse, Sawdust, paper waste, Moisture content, Ash content, Calorific value, MINITAB.*

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1. RESERCH METHODOLOGY

Step I - Selection of raw materials

Raw materials are selected for making biomass fuel on the basis of calorific values, ash content, moisture content and its easy availability. Range of calorific value, ash content and moisture content is studied and on its basis three raw materials are selected. By the combination of these three raw materials biomass fuel is made.

i. Sugarcane bagasse

Sugarcane bagasse is taken from **Shakti sugar mill Gadarwara M.P.**

Study of making sugar from sugarcane in the sugar mill is done. Three residuals are obtained after making sugar from sugarcane and they are- Sugarcane bagasse, Molasses and Press mud. The chemical analysis of these materials is done in laboratory of **Shakti Sugar Mill.** Following are the results of chemical analysis and the bagasse which is used as raw material for fuel has following values of parameters:

Bagasse which is used as raw material for fuel has following values of parameters:

Table: 1.1 Chemical analysis of the materials of sugar mill

Calorific value of bagasse	*3922.20 kcal/kg*
Calorific value of press mud	*3827.40 kcal/kg*
Calorific value of final molasses	*4234.70 kcal/kg*
Calorific value of cane dry leaves	*3703.70 kcal/kg*
Dry bagasse contains hydrogen	*6-7%*
Moisture content of bagasse	*43-52%*
Ash content of bagasse	*3%*

i. Sawdust

Sawdust of teak wood is taken from mill. Sawdust has calorific value of approx. 3898 kcal, ash content of approx. 8.2%.

ii. Paper waste

Sawdust of teak wood is taken from mill. Sawdust has calorific value of approx. 3898 kcal, ash content of approx. 8.2%.

STEP II - Experiment is designed by using software called MINITAB so that significant range of values can be obtained. Bagasse is taken 50-60%, sawdust is taken 20-40% and paper waste is taken 10-20%. The reason for taking the raw materials in this range is that sugarcane bagasse is main waste product of sugar mills which is not efficiently used also there will not be any capital investment in buying this because it is the waste material after the sugar is made and also present in large quantity. Sawdust is taken in the range of 20-40% because its cost is high as compare to bagasse, it has to be imported from mills and also it has good calorific value. Paper waste increases the calorific value also its ash content is low. In one study it is proved that on increasing the percentage of paper upto 20%, the calorific value will increase but if further its value is increased then it will start decreasing the calorific value.

STEP III - Sample is made standard weight of 1gm or 1000mg. this means range of sugarcane bagasse should be between 500-600mg, sawdust 200-400mg and paper waste of 100-200mg. by using MINITAB software design of experiment (DOE) is done. There can be infinite no. of test and combinations on which test can be done in this range. So, with the help of this software significant values on which test should be performed is obtained. 27 combinations (81 with replicates) are obtained. Combinations of raw materials to make sample are as follows

Table no. 1.2 combinations made by MINITAB [1]

S.No.	Sugarcane bagasse (mg)	Sawdust (mg)	Paper waste (mg)	Total (mg)
1.	550	400	200	1150
2.	550	400	100	1050
3.	550	200	200	950
4.	500	400	100	1000
5.	500	200	200	900
6.	600	400	100	1100
7.	600	200	150	950
8.	550	300	100	950
9.	500	200	150	850
10.	550	200	150	900
11.	500	300	100	900
12.	600	300	200	1100
13.	600	400	150	1150
14.	600	300	100	1000
15.	600	300	150	1050
16.	550	300	150	1000
17.	500	400	150	1050
18.	500	300	200	1000
19.	550	200	100	850
20.	600	400	200	1200
21.	550	400	150	1100
22.	500	400	200	1100
23.	500	300	150	950
24.	550	300	200	1050
25.	600	200	200	1000
26.	500	200	100	800
27.	600	200	100	900

But in this, total weight is not equal to 1000mg or 1gm. So, following calculations is done to make all samples of equal weight.

STEP IV - Calculations to make sample of 1000mg/1gm

1. *550 is X% of 1150*

*X/100*1150=550*

*X=550*100/1150*

X (sugarcane bagasse) = 47.82 %

Similarly 400 is y% of 1150

*Y= 400*100/1150*

Y (sawdust) = 34.78%

Similarly, 200 is z% of 1150

*Z= 200*100/1150*

Z (paper waste) = 17.39%

Now,

47.82% of 1000mg/1gm= 478.2mg

34.78% of 1000mg/1gm= 347.8mg

17.39% of 1000mg/1gm= 173.9mg

Similarly further calculations are done

STEP V- Determination of Moisture content

Percentage of Moisture content present in resulting biomass fuel can be determined with the help of DIGITAL

MOISTURE ANALYSER. In this instrument sample of greater than or equal to 0.5gm is taken. I have made sample of 1gm therefore for 0.5gm all values are divided by 2. For determining moisture content temperature is maintained at 100 degree Celsius for 10 minutes. After 10 minutes it will give percentage moisture content in the sample.

Table no. 1.3 calculated moisture content of samples taken

S.No.	Sugarcane bagasse (mg)	Sawdust (mg)	Paper waste (mg)	% moisture content
1.	239.15	173.9	86.95	8.33
2.	261.9	190.5	47.6	9.74
3.	289.5	105.25	105.25	8.96
4.	250	200	50	10
5.	277.8	111.1	111.1	10.28
6.	272.7	181.8	45.5	9.50
7.	315.8	105.3	78.9	9.74
8.	289.5	157.9	52.6	8.96
9.	294.2	117.6	88.2	9.68
10.	305.55	111.1	83.35	8.98
11.	277.75	166.7	55.55	9.15
12.	272.7	136.4	90.9	8.95
13.	260.9	173.9	65.2	12.06
14.	300	150	50	10.06
15.	285.7	142.9	71.4	9.90
16.	275	150	75	10.91
17.	238.1	190.5	71.4	10.71
18.	250	150	100	10.71
19.	323.6	117.6	58.8	11.64
20.	250	166.65	83.35	10.96
21.	250	181.8	68.2	9.25
22.	227.3	181.8	90.9	9.56
23.	263.2	157.9	78.9	8.68
24.	261.9	142.9	95.2	9.49
25.	300	100	100	9.96
26.	312.5	125	62.5	9.66
27.	333.4	111.1	55.6	9.52

STEP VI – Determination of ash content

The dried sample which is left after determining its moisture content is kept in ELECTRIC COIL HEATER and is heated so that its gases are removed and then it is kept in MUFFLE FURNACE. If it is directly keep it in muffle furnace then due to smoke produced inside furnace it will be harmed. After heating in electric coil heater the sample is kept in muffle furnace at temperature maintained at 450+-50 degrees for 3 hours. Following formula is used for calculating ash content

$$\% \text{ ash content} = \frac{\text{weight of ash}}{\text{weight of sample}} \times 100$$

Weight of ash= weight after ashing – empty crucible

Table no. 1.4 calculated ash content of samples taken.

Sample	Weight of Empty crucible(gm)	Weight of sample (gm)	Weight after ashing (gm)	Weight of ash (gm)	% ash content
1.	18.4460	0.5	18.467	0.021	4.2
2.	26.7588	0.5	26.7741	0.0153	3.06
3.	18.4589	0.5	18.4887	0.298	2.98
4.	21.5012	0.5	21.517	0.158	3.16
5.	25.1141	0.5	25.1364	0.0223	4.46
6.	27.6838	0.5	27.7255	0.0417	8.34
7.	18.4460	0.5	18.4624	0.0164	3.28
8.	26.7588	0.5	26.7735	0.0147	2.94
9.	25.1141	0.5	25.1289	0.0148	2.96
10.	27.6838	0.5	27.7059	0.0221	4.42
11.	17.8125	0.5	17.8283	0.0158	3.16
12.	18.1085	0.5	18.1212	0.0127	2.54
13.	18.1085	0.5	18.1326	0.0241	4.82
14.	17.8125	0.5	17.8350	0.0225	4.5
15.	27.6838	0.5	27.7105	0.0267	5.34
16.	25.1141	0.5	25.1355	0.0214	4.28
17.	18.4460	0.5	18.4681	0.0221	4.42
18.	26.7588	0.5	26.7744	0.0156	3.12
19.	26.7555	0.5	26.7894	0.0339	6.78
20.	18.4431	0.5	18.4505	0.0074	1.48
21.	25.1148	0.5	25.1312	0.0164	3.28
22.	27.6855	0.5	27.7020	0.0165	3.3
23.	17.8138	0.5	17.8304	0.0166	3.32
24.	18.1095	0.5	18.1246	0.0151	3.02
25.	22.1956	0.5	22.211	0.0154	3.08
26.	21.5731	0.5	21.5872	0.0141	2.82
27.	22.6431	0.5	22.663	0.0199	3.98

STEP VII – Determination of calorific value

To determine the calorific value we have to first determine the value of energy content by modified ***Dulong formula.*** For this, approximate values of moisture content for bagasse, sawdust and paper waste is taken as 45%, 20% and 6% respectively. Values of carbon, hydrogen, oxygen, nitrogen, sulphur and ash individually for sugarcane bagasse, sawdust and paper waste are given in table

Table no. 1.5 values of C, H, O, S, N and ash bagasse, sawdust and paper waste [2 to 8]

Components of sample	% ash content	% carbon	% hydrogen	% oxygen	%sulphur	% nitrogen	total
Bagasse	5	48	7	39.5	0.01	0.5	=100%
sawdust	1.5	49.8	6	41.7	0.16	0.5	=100%
Paper waste	6	43.5	6	44	0.2	0.3	=100%

Based on this table we can calculate energy content from ***DULONG FORMULA***

KJ/Kg = 337*carbon + 1428 [hydrogen – oxygen / 8] + 9*sulphur

Now,

Table no. 1.6 calculated values of C, H, O and S in samples taken [2 - 9]

S.no.	Components	Wet mass	Dry mass	%carbon	% hydrogen	% oxygen	%sulphur
1.	Bagasse	47.82	26.3	12.624	1.841	10.39	0.00263
	Sawdust	34.78	27.83	13.86	1.67	11.605	0.0445
	Paper waste	17.39	16.35	7.11	0.981	7.194	0.033
2.	Bagasse	52.39	28.82	13.83	2.02	11.39	0.0029
	Sawdust	38.09	30.48	15.18	1.83	12.71	0.0487
	Paper waste	9.52	8.95	3.893	0.537	3.94	0.018
3.	Bagasse	57.89	31.84	15.283	2.229	12.577	0.00319
	Sawdust	21.06	16.85	8.39	1.011	7.026	0.027
	Paper waste	21.05	19.79	8.608	1.188	8.708	0.03958
4.	Bagasse	50	27.5	13.2	1.93	10.87	0.0028
	Sawdust	40	32	15.94	1.92	13.35	0.0512
	Paper waste	10	9.4	4.35	0.564	4.136	0.0188
5.	Bagasse	55.55	30.55	14.65	2.139	12.067	0.00306
	Sawdust	22.23	17.79	8.86	1.068	7.42	0.0285
	Paper waste	22.22	20.88	9.083	1.253	9.188	0.0418
6.	Bagasse	54.54	29.99	14.39	2.099	11.85	0.003
	Sawdust	36.37	29.096	14.49	1.755	12.133	0.0466
	Paper waste	9.09	8.55	3.72	0.513	3.762	0.0171
7.	Bagasse	63.15	34.74	16.68	2.432	13.73	0.0035
	Sawdust	21.07	16.86	8.39	1.0116	7.0306	0.027
	Paper waste	15.78	14.84	6.455	0.8904	6.53	0.0297
8.	Bagasse	57.89	31.84	15.284	2.229	12.577	0.00319
	Sawdust	31.58	25.264	12.582	1.515	10.54	0.04043
	Paper waste	10.52	9.89	4.303	0.594	4.352	0.0198
9.	Bagasse	58.83	32.36	15.533	2.266	12.78	0.003236

	Sawdust	23.53	18.824	9.3744	1.1294	7.85	0.0302
	Paper waste	17.64	16.582	7.2132	0.995	7.296	0.0332
10.	Bagasse	61.11	33.61	16.133	2.353	13.276	0.00336
	Sawdust	22.22	17.78	8.855	1.067	7.4143	0.0285
	Paper waste	16.67	15.67	6.8165	0.9402	6.895	0.0314
11.	Bagasse	55.55	30.553	14.67	2.138	12.0685	0.003055
	Sawdust	33.34	26.67	13.282	1.6	11.122	0.04268
	Paper waste	11.11	10.45	4.545	0.627	4.598	0.0209
12.	Bagasse	54.55	30	14.4	2.1	11.85	0.003
	Sawdust	27.27	21.816	10.864	1.309	9.097	0.035
	Paper waste	18.18	17.09	7.434	1.0254	7.52	0.0342
13.	Bagasse	52.18	28.7	13.78	2.009	11.337	0.00287
	Sawdust	34.78	27.824	13.856	1.67	11.603	0.04452
	Paper waste	13.04	12.26	5.334	0.736	5.395	0.02452
14.	Bagasse	60	33	15.84	2.31	13.035	0.0033
	Sawdust	30	24	11.96	1.44	10.008	0.0384
	Paper waste	10	9.4	4.089	0.564	4.136	0.0188
15.	Bagasse	57.14	31.427	15.085	2.2	12.414	0.00315
	Sawdust	28.58	22.864	11.386	1.372	9.534	0.0366
	Paper waste	14.28	13.424	5.844	0.8055	5.9065	0.0269
16.	Bagasse	55	30.25	14.52	2.118	11.95	0.003025
	Sawdust	30	24	11.952	1.44	10.008	0.0384
	Paper waste	15	14.1	6.134	0.846	6.204	0.0282
17.	Bagasse	47.63	26.197	12.575	1.8338	10.348	0.00262
	Sawdust	38.09	30.472	15.175	1.8284	12.707	0.0488
	Paper waste	14.28	13.424	5.844	0.8054	5.9066	0.02685
18.	Bagasse	50	27.5	13.2	1.925	10.863	0.00275
	Sawdust	30	24	11.952	1.44	10.008	0.0384
	Paper waste	20	18.8	8.178	1.128	8.272	0.0376
19.	Bagasse	64.7	35.59	17.084	2.4913	14.058	0.00356
	Sawdust	23.54	18.84	9.383	1.1304	7.856	0.03015
	Paper waste	11.76	11.172	4.86	0.67032	4.9157	0.0224
20.	Bagasse	50	27.5	13.2	1.925	10.869	0.00275
	Sawdust	33.33	26.67	13.282	1.6002	11.122	0.04268
	Paper waste	16.67	15.67	6.817	0.9402	6.895	0.03134
21.	Bagasse	50	27.5	13.2	1.93	10.863	0.00275
	Sawdust	36.37	29.1	14.5	1.746	12.135	0.0466
	Paper waste	12.82	12.82	5.577	0.77	5.6408	0.0257
22.	Bagasse	45.46	25	12	1.75	9.88	0.0025
	Sawdust	36.36	29.088	14.486	1.7453	12.13	0.0466

	Paper waste	18.18	17.089	7.434	1.0254	7.52	0.0342
23.	Bagasse Sawdust Paper waste	52.64 31.58 15.78	28.95 25.27 14.834	13.89 12.585 6.453	2.027 1.517 0.89	11.436 10.537 6.527	0.0029 0.0404 0.0297
24.	Bagasse Sawdust Paper waste	52.38 28.58 19.04	28.809 23.08 17.898	13.83 11.494 7.786	2.017 1.385 1.074	11.38 9.625 7.876	0.00289 0.037 0.0358
25.	Bagasse Sawdust Paper waste	60 20 20	33 16 18.8	15.84 7.97 8.18	2.31 0.96 1.128	13.035 6.672 8.28	0.0033 0.0256 0.0376
26.	Bagasse Sawdust Paper waste	62.5 25 12.5	34.38 20 11.75	16.503 9.96 5.112	2.407 1.2 0.705	13.58 8.34 5.17	0.00344 0.032 0.0235
27.	Bagasse Sawdust Paper waste	66.67 22.22 11.11	36.67 17.78 10.444	17.602 8.855 4.542	2.567 1.067 0.627	14.485 7.415 4.596	0.00367 0.0285 0.0209

Calorific value is calculated by putting the values of total % carbon, hydrogen, oxygen and sulphur in Dulong formula and then converting energy content (KJ/Kg) to Kcal/Kg

1 KJ/Kg = 0.238846 Kcal/Kg

Now,

Table no. 1.7 calculation of energy content and calorific value (Kcal/Kg) [9]

S.no	Total % carbon	Total % hydrogen	Total % oxygen	Total % sulphur	Energy content (KJ/Kg)	Calorific value (Kcal/Kg)
1.	33.6	4.492	29.189	0.8013	12534.78	2993.8
2.	32.903	4.387	28.04	0.0696	12348.45	2949.4
3.	32.281	4.428	28.311	0.06977	12149	2901.74
4.	33.49	4.414	28.356	0.0728	12528.44	2992.36
5.	32.593	4.46	28.675	0.07336	12234.9	2922.26
6.	32.6	4.367	27.75	0.067	12269.5	2930.52
7.	31.525	4.3904	27.93	0.0667	11908.52	2844.3
8.	32.169	4.338	27.47	0.06342	12132.8	2897.87
9.	31.92	4.3904	27.926	0.0667	12042.34	2876.27
10.	31.805	4.3602	27.58	0.0633	12022.2	2871.46
11.	32.497	4.365	27.789	0.0667	12224.97	2919.88
12.	32.698	4.4344	28.467	0.0722	12270.84	2930.84
13.	32.97	4.404	28.162	0.06963	12373.52	2955.37
14.	31.89	4.314	27.179	0.0605	12056.42	2879.63
15.	32.315	4.378	27.855	0.06665	12170.42	2906.86
16.	32.606	4.404	28.162	0.06963	12250.844	2926.07
17.	33.594	4.468	28.962	0.0783	12532.47	2993.33
18.	33.33	4.493	29.143	0.0788	12446.9	2972.89
19.	31.327	4.292	26.83	0.0511	11897.48	2841.67
20.	33.3	4.466	28.89	0.0768	12443.38	2972.05

21.	33.28	4.45	28.64	0.07505	12458.4	2975.64
22.	33.92	4.5207	29.53	0.0833	12616.24	3013.34
23.	32.93	4.434	28.5	0.073	12342.57	2947.97
24.	33.11	4.48	28.89	0.0757	12399.26	2961.52
25.	32	4.4	27.98	0.0665	12073.37	2883.67
26.	31.58	4.312	27.09	0.059	11965	2857.8
27.	31	4.261	26.5	0.05307	11801.94	2818.85

2. RESULTS

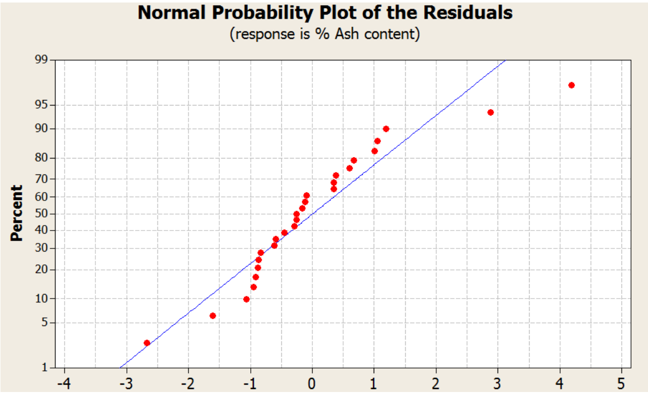

Fig no.1.1 Sugarcane bagasse Vs % ash content

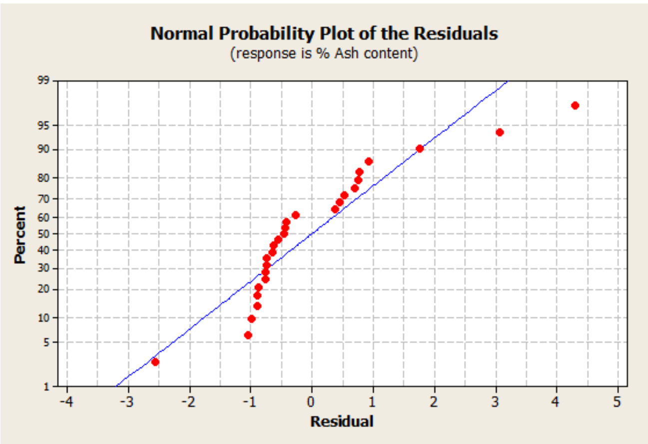

Fig no. 1.2 Sawdust Vs % Ash content

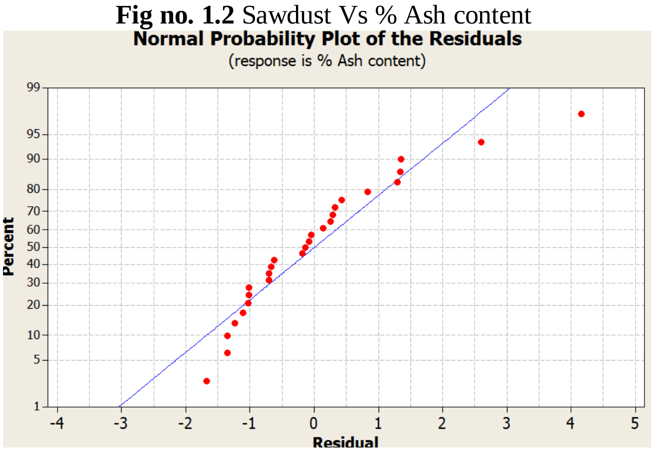

Fig no. 1.3 paper waste Vs % Ash content

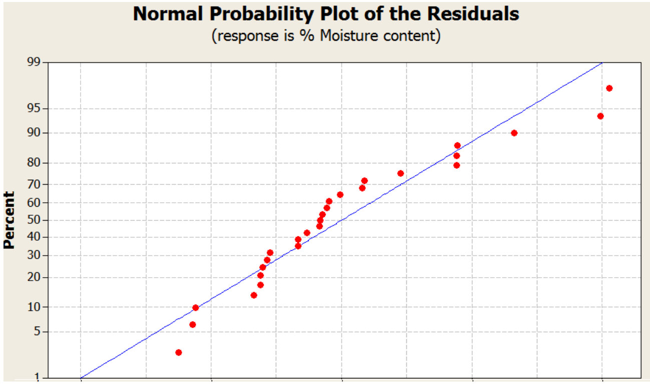

Fig no. 1.4 Sugarcane bagasse Vs % Moisture content

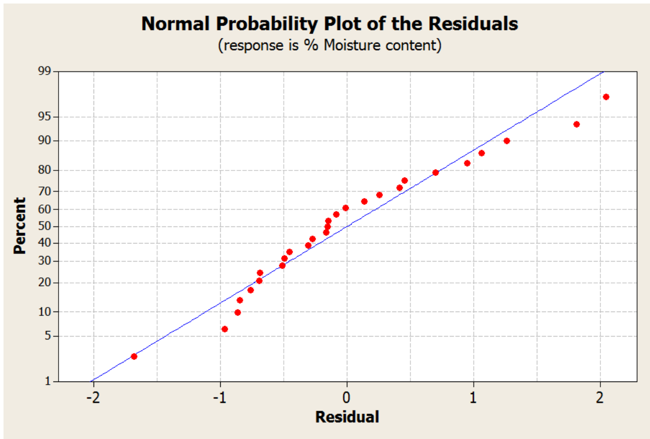

Fig no. 1.5 Sawdust Vs % Moisture content

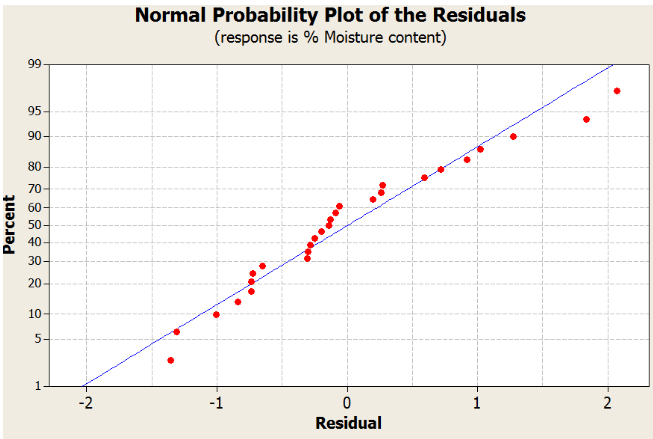

Fig no. 1.6 Paper waste Vs % Moisture content

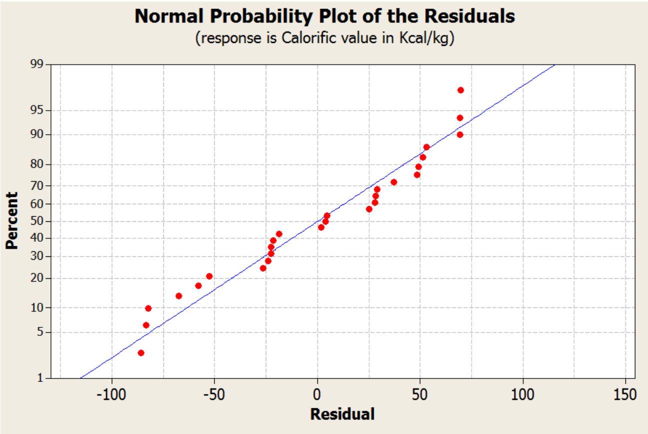

Fig no. 1.7 Sugarcane bagasse Vs Calorific value

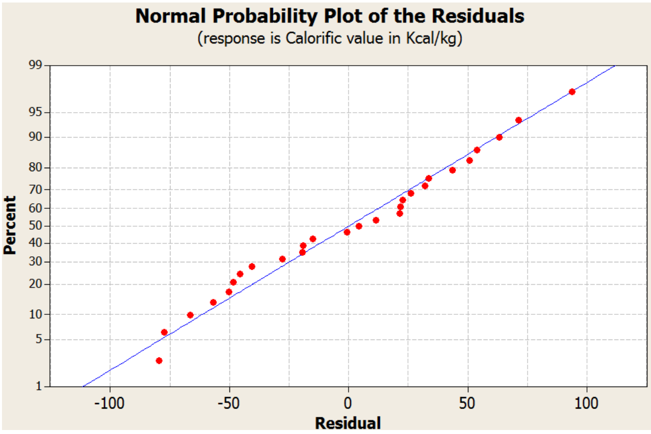

Fig no. 1.8 Sawdust Vs Calorific value

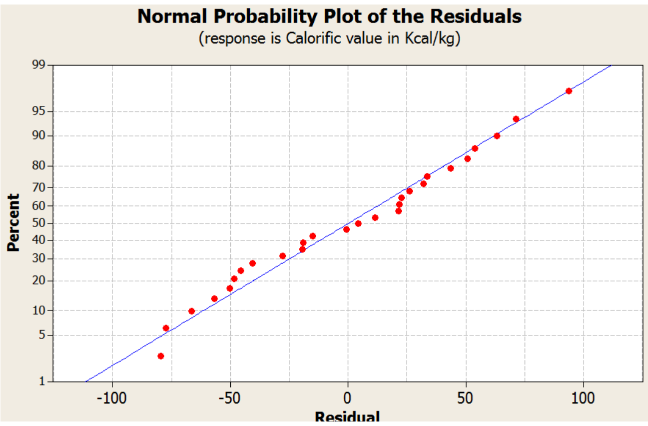

Fig no. 1.9 Paper waste Vs Calorific value

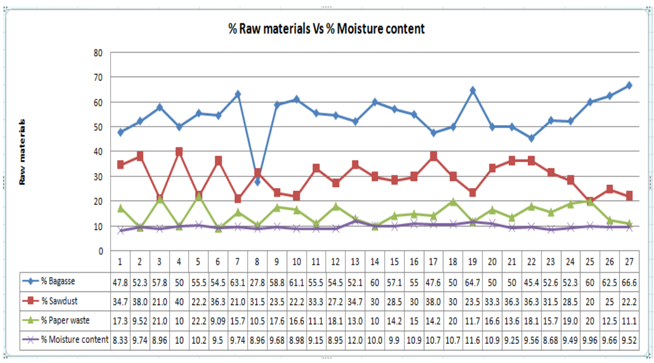

Fig no. 1.10 % raw materials Vs % moisture content

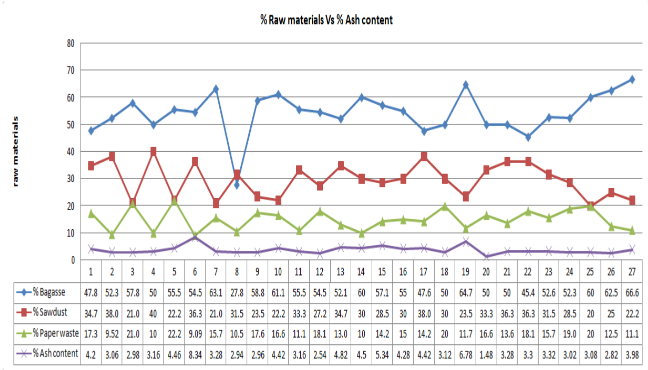

Fig no. 1.11 % raw materials Vs % ash content

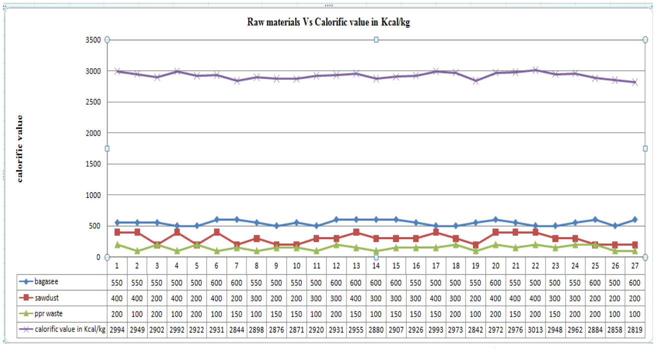

Fig no. 1.12 % raw materials Vs Calorific value

3. DISCUSSION

The results which are obtained from the test is analysed in MINITAB SOFTWARE. Normality plot is drawn in software. There is the line of significance in normality plot. Test results of 27 samples are put and ANOVA ONE WAY Analysis is done.

- ❖ Effect on ash content is analysed separately for sugarcane bagasse, sawdust and paper waste. From fig no. 1.1 it is seen that almost all points are near to the line of significance. Samples 26 and 27 are little away from the line of significance that means these values of sugarcane bagasse are less significant.

  Similarly if we see the effect of ash content with respect to sawdust value in the sample then we conclude from fig no. 1.2 that four points are little far from the line of significance i.e. sample no. 2,3,26 and 27 means theses values of sawdust are less significant with respect to ash content values.

  Now, we will observe the effect of ash content with respect to the values of paper waste. From fig no. 1.3 it is seen that except for points 1,2,26 and 27 all points means all values of sawdust are near line of significance.

  At last effect of the combination of all raw materials in the samples is observed with respect to the value of % ash content and it is seen from fig no. 1.11 for sample no. 6 and 19 the value of ash content is high. And it is beyond the expected value.
- ❖ Effect on moisture content is analysed separately for sugarcane bagasse, sawdust and paper waste. We will analyze fig no. 1.4 and we see that except for points 1, 26 and 27 rest all points are near line of significance.

Similarly, if we see the effect of sawdust on the value of moisture content then we conclude from fig no. 1.5 that only point 2, 26 and 27 are little away from the line of significance and rest all points are near the line of significance.

Now, the value of moisture content with respect to paper waste is observed. From fig no. 1.6 it is seen that only points 26 and 27 are away from the line of significance.

Effect of all raw materials on % moisture content is observed from fig no. 1.10 and it is concluded that nowhere graph has high or low points and graph is considered as constant and all samples are significant with the view point of moisture content. Usually biomass has wide range of moisture content from less than 10 to 50- 70% in forest residues [10]

- ❖ Effect on calorific value is seen with respect to sugarcane bagasse. From the normality plot of fig no. 1.7 it clear that only point 27 has less significant value of calorific value and all other values of sugarcane bagasse are significant for calorific value.

  Effect on calorific value on changing the value of sawdust is seen from fig no. 1.8 and it is concluded that all points are significant because all lie near the line of significance only point 1 is slightly away from the significant line.

  The fig no 1.9 is observed which shows the effect on calorific value with respect to the values of paper waste and it is seen that all points lie near the line of significant and all values of paper waste taken for making samples are significant.

  Effect of raw materials on the calorific value is observed from fig no. 1.12 and seen that calorific value of all samples is near to 3000 Kcal/kg which is considerably high value.
- ❖ It is concluded from all normality plots that samples 26 and 27 are less significant. So these values of sugarcane bagasse, sawdust and paper waste can be avoided for making biomass fuel or biomass briquettes.

4. CONCLUSION

Thorough study and analysis is done of all the samples which are made by the combination of sugarcane bagasse, sawdust and paper waste and the test are performed to determine the value of moisture content and ash content while the value of energy content is calculated by using modified Dulong Formula in KJ/kg and then it is converted to Kcal/kg to get calorific value. It is concluded from the results of the samples that ash content of all the samples and moisture content of the fuel in coming in the range and most importantly their values are less than that obtained from the analysis of coal whereas calorific value of biomass is less than the calorific value of coal.

From graphs and normality plot it is concluded that all samples which are taken for test are significant except for sample no. 26 and 27. This means the ratios in which raw materials are mixed in theses samples are not significant so the use of this ratio is avoided and rest all points are near the line of significance.

Bioenergy acquires second position in world's commercial energy sources. It has been only used for traditional applications like cooking [11] but this should also be used for commercial applications. As, for biomass fuels calorific value is not as much as that of coal there is a view to use biomass materials in co generation with coal in boilers in thermal power stations. Our main aim of using renewable energy sources is to reduce the dependence of world on conventional and non renewable sources of energy because they are depleting very rapidly and most importantly it emits green house gases which are the main reason of global warming.

5. REFERRENCES

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