

**RESEARCH PAPER**

# Studies on combustion of agricultural waste

**■ S.P. KURHEKAR, S.K. JAIN AND P.P. CHAVAN****ABSTRACT**

Coconut husk, areca nut husk, rice husk, saw dust and there combinations were used for experiment. The average moisture content were 12.09 per cent, 14.65 per cent, 15.09 per cent and 14.86 per cent for coconut husk, areca nut husk, rice husk, and saw dust, respectively. The average bulk density was 76.32 kg/m<sup>3</sup>, 81.98 kg/m<sup>3</sup>, 109.66 kg/m<sup>3</sup> and 199.84 kg/m<sup>3</sup> for coconut husk, areca nut husk, rice husk and saw dust, respectively. The average residue collected were obtained as 12.64 per cent, 10.77 per cent, 11.69 per cent, 48.18 per cent, and 38.43 per cent for T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub>, and T<sub>5</sub>, respectively. Biomass was analyzed for temperature and burn in developed burning chamber. The combustion study was carried in burning chamber. 1kg sample, it was observed that the temperature increases from 29.16 to 167.66 °C, 29.46 to 155 °C, 29.53 to 146.3 °C and 30.4 to 143.13 °C for T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub>, respectively during 20 min of durations. 2 kg sample, it was observed that the temperature increases from 28.8 to 180.96 °C, 29 to 165.36 °C and 28.5 to 146.43 °C for T<sub>2</sub>, T<sub>3</sub>, and T<sub>4</sub>, respectively during 20 min of durations. But in case of T<sub>1</sub> and T<sub>2</sub> temperature increases from 29.26 to 232.56 °C and 30.06 to 152.73 °C during 0 to 15 minute of duration, respectively . For combustion of 3 kg sample, it was observed that the temperature increases from 29.5 to 248.96 °C, 29.96 to 227.46 °C, 29.6 to 174.13 °C and 30.73 to 165.8 °C for T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub>, respectively during 20 min of duration. But in case of T<sub>1</sub> temperature increases from 29.8 to 304.5 °C during 0 to 15 minute. The results indicated that coconut husk and areca nut husk were good for combustion in developed burning chamber. Burning of sawdust and rice husk and there combinations were not suitable for burning in developed burning chamber.

**KEY WORDS :** Biomass, Combustion, Agricultural waste**How to cite this Article :** Kurhekar, S.P., Jain, S.K. and Chavan, P.P. (2015). Studies on combustion of agricultural waste. *Engg. & Tech. in India*, 6 (2) : 89-93.**INTRODUCTION**

The decreasing availability of fuel like wood, coupled with the ever-rising prices of kerosene and cooking gas in India, has drawn attention to the need to consider alternative sources of energy for domestic and cottage level industrial use in the country (Lucas and Akinoso, 2001). Traditionally, wood in form of fuel wood and twigs has been the major source of renewable energy in India. As rightly noted by Stout and Best (2001). A transition to a sustainable energy system is urgently needed in the developing countries such as India with the increase in world population and the rise of living standards, the demand for energy in the world is steadily increasing. To cope with increasing demands for biomass energy and feedstocks (Kuti and Adegoke, 2008) integrated systems for biomass production, conversion and utilization of photosynthetic resources should be developed. Utilization of rice husk, sawdust and charcoal as alternative sources for fuel in drying have made these products more valuable rather than considering them as agricultural wastes. Appropriate combustion properties of fuel materials are essential during drying, blanching and storage operation and

are equally necessary in the design and analysis of the numerous machines and processes involving heat treatment.

## **EXPERIMENTAL PROCEDURE**

### **Treatment :**

Available biomass was taken in different combination and sample size was 1 kg, 2 kg, and 3 kg.

T<sub>1</sub>- Coconut huk (100%)

T<sub>2</sub>- Arecanut husk (100%)

T<sub>3</sub>- Coconut husk (50%) + arecanut husk (50%)

T<sub>4</sub>- Coconut husk (50%) + rice husk (50%)

T<sub>5</sub>- Coconut husk (50%) + saw dust (50%).

### **Bulk density :**

The bulk density of all the biomass was calculated by using the formula.

$$\text{B.D.} = \frac{W_s}{V_c}$$

where,

B.D. = bulk density of given sample, kg/m<sup>3</sup>

W<sub>s</sub> = weight of sample accommodated in the water bucket, kg

V<sub>c</sub> = volume of the bucket, m<sup>3</sup>

### **Moisture content :**

The moisture content was determined by hot air oven method (ASTM.D-3172 1984). Samples were dry with natural air circulation and temperature regulation between 104°C to 110°C for one hour.

The moisture content was determined by using the formula:

$$\text{M.C.} = \frac{W_w - W_d}{W_d} \times 100$$

where,

M.C. = moisture content on wet basis, kg

W<sub>w</sub> = weight of moisture sample, kg

W<sub>d</sub> = weight of dried sample, kg.

### **Residue collected :**

Combustion of sample each of 1.0 kg, 2.0 kg and 3.0 kg was carried out in combustion chamber. When the combustion was complete, the burnt fuel was cooled on thick metal plate. The weight of residue was determined by weighing on weighing balance.

### **Instrument used :**

Hot air oven with temperature range of ambient to 250<sup>o</sup> ± 1<sup>o</sup>C with digital temperature indicator cum controller with timer and inner chamber 600(W) × 600(D) × 900(H) mm was use for the determination of dry basis moisture content Electronic weighing balance was use for accurate measurement of weight with least count 0.01g. The stopwatch manufactured by RACER electronic company was used to measure the time of treatment. Its range was 0-15 minutes with least count of 5 seconds and accuracy was 1/100 second. Hot wire Thermometer was used for measurement of the flame temperature during the experiment.

## **EXPERIMENTAL FINDINGS AND ANALYSIS**

The findings of the present study as well as relevant discussion have been presented under the following heads in Tables

1 to 3.

### Dimensions of heating chamber :

- Length = 0.49 m
- Width = 0.49 m
- Height = 0.30m
- Air inlet 0.06 m diameter pipe
- Ash outlet 0.05 m x 0.49 m

### Moisture content :

The moisture content of biomass samples was determined. The average moisture content were obtained as 12.09 per cent, 14.65 per cent, 15.09 per cent and 14.86 per cent for coconut husk, areca nut husk, rice husk and saw dust,

Table 1 : Temperature recorded during combustion study of 1 kg biomass sample					
Time (min)	Temperature ( $^{\circ}$ C )				
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>
0	29.5	29.1	29.4	29.5	30.4
5	73.2	54.8	57.2	61.2	59.8
10	146.8	99.9	88.6	90.2	85.9
15	169.7	153.3	149.4	134.9	141.9
20	163.1	167.6	155.0	146.3	143.1
25	135.4	134.9	119.5	104.0	106.2
30	100.8	90.3	61.8	54.7	54.9
35	73.5	57.9	54.7	48.2	50.1
40	49.7	46.6	47.4	42.7	45.2
45	44.5	42.3	40.7	36.0	40.3
50	40.5	38.2	36.5	32.2	35.4
55	38.0	34.7	33.2	30.9	31.8
60	34.9	31.2	30.7	27.4	28.3

Table 2 : Temperature recorded during combustion study of 2 kg biomass sample					
Time (min)	Temperature ( $^{\circ}$ C )				
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>
0	29.2	28.8	29.0	28.5	30.0
5	124.7	72.3	82.0	65.5	66.1
10	225.3	129.7	118.9	108.3	114.8
15	232.5	165.6	161.5	140.4	152.7
20	202.4	180.9	165.3	146.4	149.0
25	154.1	156.4	132.7	123.7	113.4
30	120.6	103.6	104.3	96.2	91.3
35	95.3	76.5	75.9	73.2	73.5
40	73.8	56.7	57.0	53.5	57.9
45	60.2	51.8	44.3	40.8	45.1
50	53.6	47.2	39.5	38.4	40.4
55	48.8	40.0	37.4	35.9	36.4
60	44.3	36.4	34.4	32.1	33.5

Table 3 : Temperature recorded during combustion study of 3 kg biomass sample					
Time (min)	Temperature ( $^{\circ}\text{C}$ )				
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>
0	29.8	29.5	29.9	29.6	30.7
5	168.9	96.5	87.4	63.6	69.7
10	296.9	187.7	170.4	105.5	113.3
15	304.5	225.4	211.1	137.2	137.8
20	258.3	248.9	227.4	174.1	165.8
25	213.2	178.1	162.1	146.2	161.3
30	167.4	133.4	124.3	117.0	127.7
35	121.9	97.2	93.2	88.6	92.8
40	91.5	69.3	78.1	63.3	73.6
45	72.2	59.5	58.3	47.1	60.4
50	58.9	47.7	45.7	40.7	49.7
55	53.0	41.4	39.3	36.4	43.7
60	49.0	37.2	36.1	34.6	41.6

respectively.

#### Bulk density :

The average bulk densities were obtained as 76.32 kg/m<sup>3</sup>, 81.98 kg/m<sup>3</sup>, 109.66 kg/m<sup>3</sup> and 199.84 kg/m<sup>3</sup> of coconut husk, areca nut husk, rice husk and saw dust, respectively.

#### Residue collected :

The residues of selected biomass samples were recorded. The average residues were obtained as 12.64 per cent, 10.77 per cent, 11.69 per cent, 58.13 per cent and 57.73 per cent of T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub>, and T<sub>5</sub>, respectively.

#### Temperature recorded during combustion :

For 1 kg of sample it was observed that the temperature increased from 34.66 $^{\circ}\text{C}$  to 167.70 $^{\circ}\text{C}$ , 35 $^{\circ}\text{C}$  to 165.01 $^{\circ}\text{C}$ , 36.00 $^{\circ}\text{C}$  to 146.36 $^{\circ}\text{C}$  and 34.23 $^{\circ}\text{C}$  to 143.21 $^{\circ}\text{C}$  for T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub>, respectively during 20 min of duration. But in case of T<sub>1</sub> temperature increases from 32 $^{\circ}\text{C}$  to 169.82 $^{\circ}\text{C}$  during 0 to 15 min. of duration.

For 2 kg sample it was observed that the temperature increased from 36.1 $^{\circ}\text{C}$  to 180.97 $^{\circ}\text{C}$ , 34.66 $^{\circ}\text{C}$  to 165.42 $^{\circ}\text{C}$ , and 35.33 $^{\circ}\text{C}$  to 146.48 $^{\circ}\text{C}$  for T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub>, respectively during 20 min of duration. But in case of T<sub>1</sub> and T<sub>2</sub> temperature increased from 34.19 $^{\circ}\text{C}$  to 232.64 $^{\circ}\text{C}$ , and 35.76 $^{\circ}\text{C}$  to 152.79 $^{\circ}\text{C}$  during 0 to 15 min. of duration.

3 kg sample was kept for burning in developed chamber. It was observed that the temperature increased from 34.41 $^{\circ}\text{C}$  to 304.57 $^{\circ}\text{C}$ , 36.11 $^{\circ}\text{C}$  to 261.6 $^{\circ}\text{C}$ , 34.00 $^{\circ}\text{C}$  to 201.32 $^{\circ}\text{C}$ , 32.33 $^{\circ}\text{C}$  to 169.15 $^{\circ}\text{C}$  for T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, and T<sub>4</sub>, respectively during 15 min of duration. But in case of T<sub>5</sub> temperature increases from 34.50 $^{\circ}\text{C}$  to 165.87 $^{\circ}\text{C}$  during 0-15 min duration (Ayhan, 2004; Fang *et al.*, 2004; Guillaume, 2007; Klasnja *et al.*, 2002; Saenger *et al.*, 2000 and Umamaheswaran and Batra, 2008; Kumbhar, 2012 and Raghupati *et al.*, 2012).

#### Conclusion :

It was observed that the temperature increases with duration of heating to its maximum up to 15 min of heating thereafter it starts decreasing.

Temperature of 100 $^{\circ}\text{C}$  is obtained with all the fuels type with in duration of 10 minutes and it lasts for about 30 minutes after which it starts decreasing. Maximum temperature of was obtained with the fuel coconut husk in 15

minutes of burning followed by arecanut husk in 20 minutes of burning.  
 Coconut husk attended higher temperature in short time with less smoke.  
 Rice husk and saw dust emits more smoke and produced low temperature.

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