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To study the burning duration of biomass

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Abstract

Utilization of coconut husk, areca nut husk, rice husk and sawdust as alternative sources for fuel in drying have made these products more valuable rather than considering them as agricultural wastes. Coconut husk, areca nut husk, rice husk, saw dust and their combinations were used for experiment. The average moisture content were 12.09%, 14.65%, 15.09% and 14.86% for coconut husk, areca nut husk, rice husk, and saw dust respectively. The average bulk density was 76.32 Kg/m^3, 81.98 Kg/m^3, 109.66 Kg/m^3 and 199.84 Kg/m^3 for coconut husk, areca nut husk, rice husk, and saw dust respectively. The average residue collected were obtained as 12.64%, 10.77%, 11.69%, 48.18%, and 38.43% for T_1, T_2, T_3, T_4, and T_5 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 ^{0}C, 29.46 to 155 ^{0}C, 29.53 to 146.3 ^{0}C and 30.4 to 143.13 ^{0}C for T_2, T_3, T_4, and T_5 respectively during 20 min of durations. 2kg sample, it was observed that the temperature increases from 28.8 to 180.96 ^{0}C, 29 to 165.36 ^{0}C and 28.5 to 146.43 ^{0}C for T_2, T_3, and T_4 respectively during 20 min of durations. But in case of T_1 and T_2 temperature increases from 29.26 to 232.56 ^{0}C and 30.06 to 152.73 ^{0}C during 0 to 15 minute of duration respectively. For combustion of 3kg sample, it was observed that the temperature increases from 29.5 to 248.96 ^{0}C, 29.96 to 227.46 ^{0}C, 29.6 to 174.13 ^{0}C and 30.73 to 165.8 ^{0}C for T_2, T_3, T_4, and T_5 respectively during 20 min of duration. But in case of T_1 temperature increases from 29.8 to 304.5^{0}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 their combinations were not suitable for burning in developed burning chamber.

Key words: Biomass, combustion, rice husk

Introduction

With the increase in world population and the rise of living standards, the demand for energy in the world is steadily increasing. Global environmental issues and exhaustion of fossil resources also pose serious problems for energy consumption. Environment friendly energy technology and a shift to non fossil energy resources such as natural energy and biomass are expected. A rapid increase in world population also demanded a huge amount of food, which is another form of essential energy for mankind. Oil crisis and the environmental issues restricted the expansion of energy consumption. Improved energy conversion and a utilization system for effective use of energy with less environmental load are now needed. Improved quality of life also demands more living necessaries and utensils. 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. A transition to a sustainable energy system is urgently needed in the developing countries such as India To cope with increasing demands for biomass energy and feedstock, 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

Materials and Methods

Treatment

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

T_1- Coconut huk (100%)

T_2- Arecanut husk (100%)
T_3- Coconut husk (50%) + Arecanut husk (50%)
T_4- Coconut husk (50%) + Rice husk (50%)
T_5- Coconut husk (50%) + Saw dust (50%)

Bulk density:

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

$$B.D. = \frac{Ws}{Vc}$$

Where,

B.D. = bulk density of given sample, kg/m^3

Ws = weight of sample accommodated in the water bucket, kg

Vc = volume of the bucket, m^3

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^{0}C to 110^{0}C for one hour.

The moisture content was determined by using the formula:

$$M.C. = \frac{Ww - Wd}{Wd} \times 100$$

Where,

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

Ww = weight of moisture sample, kg

Wd = 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 250^0 ± 1^{0}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 0.01gm 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.

Results and Discussion

Design Calculations

The dimensions of heating chamber were decided on the basis of quantity of fuel required.

Fuel Requirement:

$$F = \frac{q_a}{\eta \times \eta_{ex} \times C_n}$$

Where,

F Fuel rate, kg/hr.

q_a Total heat required to heat the drying air, kcal/hr.

C_n Calorific value of fuel, kcal/kg. :

n Combustion efficiency : 0.65

$ç_{ex}$ Heat exchanger efficiency : 0.35

$q_a = W_1 [(X_{id} – X_{fd}) ë + C_{pc} (t_{ci} – t_{cf}) + C_{pw} (t_{ci} – t_{cf}) X_{id}$

W_1 Bone dry Arecanut in kg. : 5 kg

X_{id} Initial moisture content of Arecanut, (d.b.) in fraction. : 0.711

X_{fd} Final moisture content of Arecanut, (d.b.) in fraction. : 0.053

ë Latent heat of water vapour in kcal/kg. : 600 kcal/kg

C_{pc} Specific heat of Arecanut in kcal/kg^{0}C. : 0.28 kcal/kg ^{0}C

C_{pw} Specific heat of water in kcal/kg^{0}C. : 1.0 kcal/kg ^{0}C

t_{ci} Initial temp. of Arecanut in ^{0}C. : 27 ^{0}C

t_{cf} Final temp. of Arecanut in ^{0}C. : 55 ^{0}C

H Humidity at ambient air in kg/kg. : 0.02 kg/kg

t_2 Drying temp. of air in ^{0}C. : 65 ^{0}C

Drying period of Areca nut in hrs. : 30hrs

q_a = 1792.6 kcal/hr.

For arecanut husk

$$F = \frac{q_a}{\eta \times \eta_{ex} \times C_n} = 1792.6/\ 973.24 = 1.84 \text{ Kg/hr}$$

For rice husk = 1792.6/ 837.2 = 2.14 Kg/hr

For coconut husk = 1792.6/ 796.2 = 2.25 Kg/hr

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%, 14.65%, 15.09% and 14.86% for coconut husk, areca nut husk, rice husk, and saw dust respectively.

Bulk Density

The average bulk densities were obtained as 76.32 Kg/m^3, 81.98 Kg/m^3, 109.66 Kg/m3 and 199.84 Kg/m^3 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%, 10.77%, 11.69%, 58.13%, and 57.73% of T_1,

T_2, T_3, T_4, and T_5 respectively.

Temperature recorded during combustion

For 1 kg of sample it was observed that the temperature increases from 34.66 ^{0}C to 167.70 ^{0}C, 35 ^{0}C to 165.01^{0}C, 36.00 ^{0}C to 146.36 ^{0}C and 34.23 ^{0}C to 143.21 ^{0}C for T_2, T_3, T_4 and T_5 respectively during 20 min of duration. But in case of T_1 temperature increases from 32 ^{0}C to 169.82 ^{0}C during 0 to 15 min. of duration.

Table 1: Temperature recorded during combustion study of 1 kg biomass sample

Time (min)	Temperature (^{0}C)				
	T_1	T_2	T_3	T_4	T_5
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 (^{0}C)				
	T_1	T_2	T_3	T_4	T_5
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

For 2kg sample it was observed that the temperature increases from 36.1^{0}C to 180.97^{0}C, 34.66^{0}C to 165.42^{0}C, and 35.33^{0}C to 146.48 ^{0}C for T_2, T_3, and T_4 respectively during 20 min of duration. But in case of T_1 and T_2 temperature increases from 34.19^{0}C to 232.64 ^{0}C, and 35.76^{0}C to 152.79 ^{0}C during 0 to 15 min. of duration.

3kg sample was kept for burning in developed chamber. It was observed that the temperature increases from 34.41 ^{0}C to 304.57 ^{0}C, 36.11 ^{0}C to 261.6 ^{0}C, 34.00 ^{0}C to 201.32 ^{0}C, 32.33 ^{0}C to 169.15 ^{0}C for T_1, T_2, T_3, and T_4 respectively during 15 min of duration. But in case of T_5 temperature increases from 34.50 ^{0}C to 165.87 ^{0}C during 0-15 min duration.

Table 3: Temperature recorded during combustion study of 3 kg biomass sample

Time (min)	Temperature (^{0}C)				
	T_1	T_2	T_3	T_4	T_5
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

References

Ayhan Demirbas, (2004). Combustion characteristics of different biomass fuels. Progress in Energy and Combustion Science. Vol.30 (2). pp: 219-230.

Guillaume Pilon, (2007). Utilization of Areca nut (*Areca catechu*) Husk for Gasification, Department of Bio-resource Engineering, McGill University, Montreal. pp: 171-172.

Klasnja B., S. Kopitovic and S. Orlovic, (2002). Wood and bark of some popular and willow clones as fuel wood. Biomass and bioenergy. pp: 427-432

K.Umamaheswaran and Vidya S. Batra, (2008). Physico-chemical characterization of Indian Fuel. Vol.87(6). pp: 628-638.

M. Fang, L.Yang, G. chen, Z. Shi, Z Luo, K. Cen, (2004). Experimental study on rice husk combustion in circulating fluidized bed. Fuel Processing Technology. Vol.85(11). pp: 1273-1282.

Saenger M., J Werther, E. U. Hartge, T Ogada, Z Siagi, (2000). Combustion of agriculture residues. Progress in energy and combustions science. Vol.26(1). pp: 1-27.